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NATIONAL DAM SAFETY PROGRAM. TIMBER LAKE DAM (NJ 00416), DELAWA--ETC(U)
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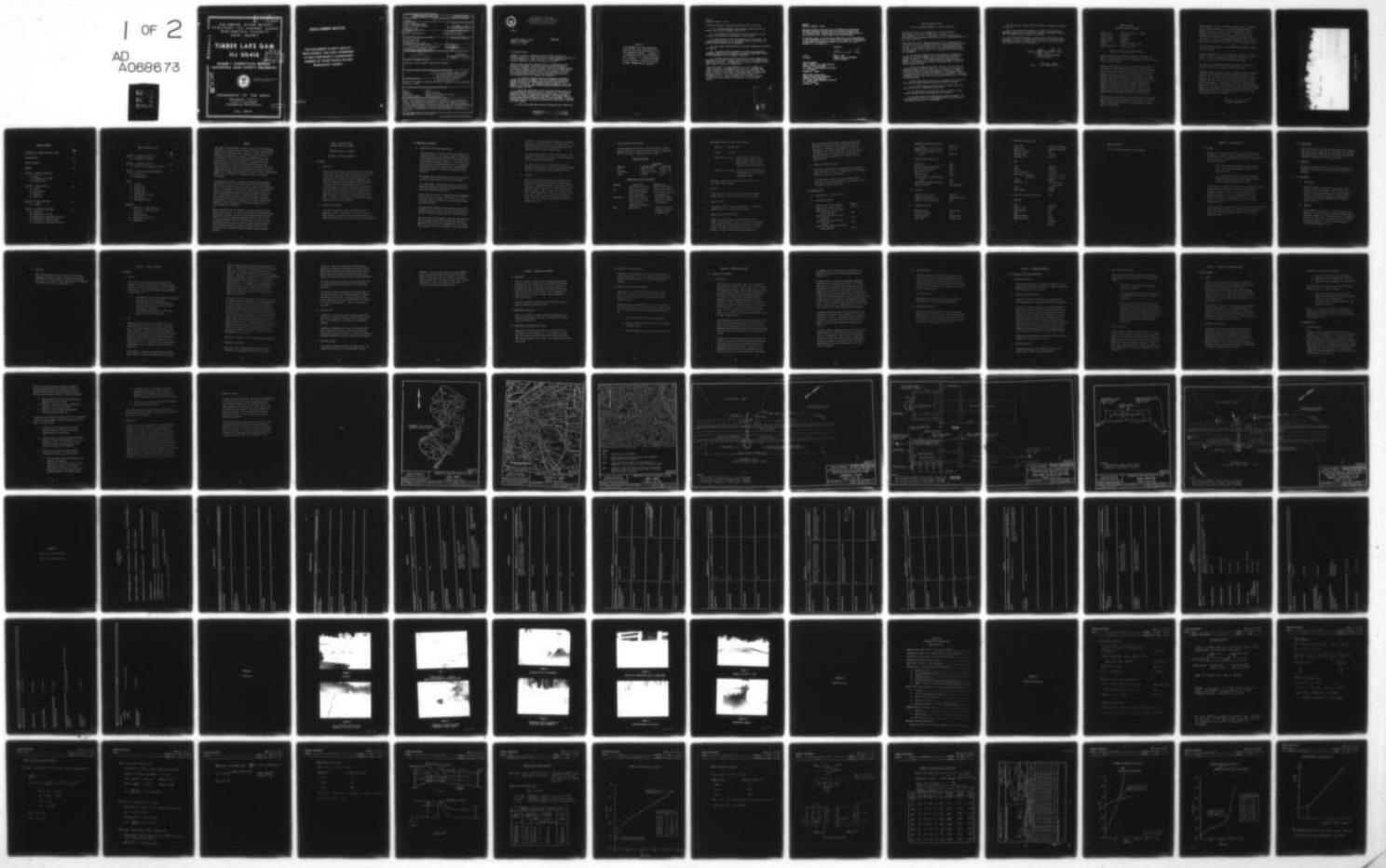

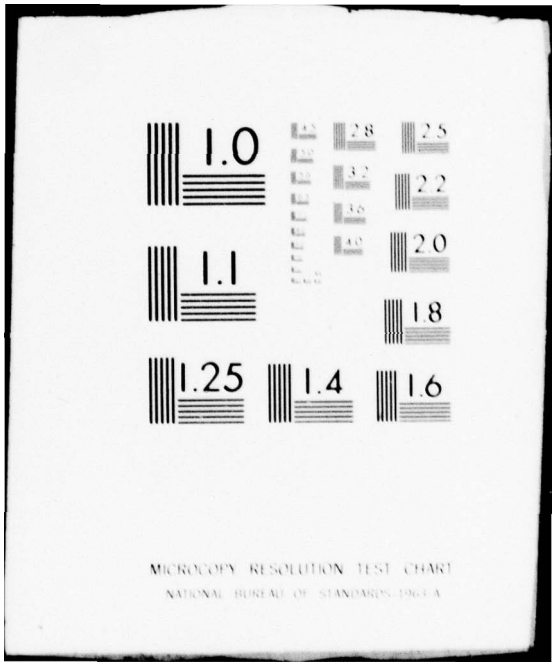
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DELAWARE RIVER BASIN
TRIBUTARY TO HAYNES CREEK
BURLINGTON COUNTY
NEW JERSEY

TIMBER LAKE DAM

NJ 00416

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Approved for public release;
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DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

May, 1979

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REPORT DOCUMENTATION PAGE

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(6) National Dam Safety Program. Timber Lake Dam (NJ 00416), Delaware River Basin, Tributary to Haynes Creek, Burlington County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	Safety
Spillway	Visual Inspection
Embankment	National Dam Inspection Act Report
Structural Analysis	Timber Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

9 MAY 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Timber Lake Dam in Burlington County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Timber Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 21 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within six months from the date of approval of this report the downstream reservoir should be lowered to expose the toe of the dam and engineering studies and inspections should be performed to determine if there is a seepage problem in the embankment. Any remedial measures found necessary should be initiated within calendar year 1980. A detailed topographic survey of the dam and surrounding area should also be performed for record purposes.

c. Within three months from the date of approval of this report the

steel grate and walkway covering the spillway should be replaced.

d. The following remedial actions should be completed within six months from the date of approval of this report:

(1) The depressions in the dam crest should be filled to create a level crest and prevent channelization of any overflow.

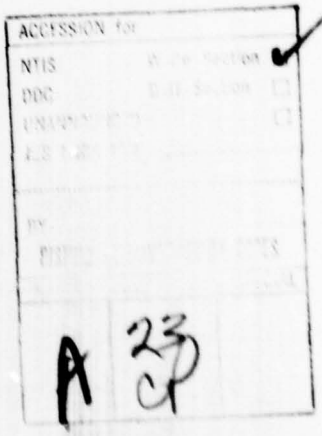
(2) Trees and brush on the dam embankment should be removed. All trees and brush should be cut at the ground surface in a way that will cause minimal disturbance to the embankment.

(3) The concrete spillway should be thoroughly inspected and repaired as necessary.

(4) A detailed design for regrading the upstream and downstream embankment slopes should be prepared by a qualified professional engineer and the embankment should be regraded accordingly.

(5) The owner should initiate a program of periodic inspection and maintenance of the dam, including complete records of all inspections and maintenance performed. A standard check list similar to the one in this report should be used for the inspections.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Edwin B. Forsythe of the Sixth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.



NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
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TIMBER LAKE DAM (NJ00416)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 19 December 1978 by Storch Engineers under contract to the State of New Jersey. The state, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Timber Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 21 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within six months from the date of approval of this report the downstream reservoir should be lowered to expose the toe of the dam and engineering studies and inspections should be performed to determine if there is a seepage problem in the embankment. Any remedial measures found necessary should be initiated within calendar year 1980. A detailed topographic survey of the dam and surrounding area should also be performed for record purposes.

c. Within three months from the date of approval of this report the steel grate and walkway covering the spillway should be replaced.

d. The following remedial actions should be completed within six months from the date of approval of this report:

(1) The depressions in the dam crest should be filled to create a level crest and prevent channelization of any overflow.

(2) Trees and brush on the dam embankment should be removed. All trees and brush should be cut at the ground surface in a way that will cause minimal disturbance to the embankment.

(3) The concrete spillway should be thoroughly inspected and repaired as necessary.

(4) A detailed design for regrading the upstream and downstream embankment slopes should be prepared by a qualified professional engineer and the embankment should be regraded accordingly.

(5) The owner should initiate a program of periodic inspection and maintenance of the dam, including complete records of all inspections and maintenance performed. A standard check list similar to the one in this report should be used for the inspections.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 9 May 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Timber Lake Dam, I.D. NJ00416
State Located:	New Jersey
County Located:	Burlington
Drainage Basin:	Delaware
Stream:	Tributary to Haynes Creek
Date of Inspection:	December 19, 1978

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, Timber Lake Dam is assessed as being in fair overall condition.

Hydraulic and hydrologic analyses indicate that the spillway is inadequate. Discharge from the spillway is not sufficient to pass the designated spillway design flood (SDF) without an overtopping of the dam. (The SDF for Timber Lake Dam is equal to one-half the probable maximum flood.) The spillway is capable of passing approximately 10 percent of the probable maximum flood. Therefore, the owner should engage a qualified professional engineer soon to perform accurate hydraulic and hydrologic analyses relating to the spillway capacity. Based on the findings of the analyses, remedial measures should be undertaken to correct the inadequate condition of the spillway.

Two depressions in the dam crest, one at either end of the embankment, have been provided as overflow areas for high lake water levels. These should be filled in the near future in order to form a level dam crest.

The embankment is free of settlement and appears to be structually sound. However, assessment of any possible seepage cannot be made due to the fact that part of the downstream toe of dam is submerged by tailwater (Oakwood Lake). Inspection of the downstream toe with Oakwood Lake lowered should be performed in the near future. In addition, the embankment should be regraded in the near future to eliminate excessively steep side slopes and erosion.

Trees and brush are present on the embankment and should be removed in the near future.

The spillway appears to be in good condition. However, in the near future, it should be thoroughly inspected and renovated by sand blasting, coating with epoxy and grouting where needed.

The steel grate and walkway covering the spillway is structurally unsound and hazardous and should be replaced very soon.

The owner should, in the near future, implement a program of periodic inspection and maintenance for the dam which would include a topographic survey to provide a record of existing conditions. Repairs should be made when required and the following maintenance should be performed annually: remove adverse vegetation from the embankment and fill and sod any eroded surfaces. As part of the maintenance program, the lake should be lowered at least every five years at which time the lake should be cleaned and submerged portions of the dam and spillway inspected and repaired.

Richard J. McDermott

Richard J. McDermott, P.E.

OVERVIEW - TIMBER LAKE DAM

19 DEC. 1978

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 30214. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

TIMBER LAKE DAM, I.D. NJ00416

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Timber Lake Dam was made on December 19, 1978. The purpose of the inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description of Dam and Appurtenances

Timber Lake Dam is an earthfill dam with a concrete box drop-inlet spillway. The spillway, which is covered with a steel grate and walkway, functions in both controlled and uncontrolled modes as follows: 1. The sides of the drop-inlet form an uncontrolled weir and 2. stoplogs at the upstream end of the spillway form a controlled weir discharging through a sluice into the main drop-inlet structure.

The stoplogs forming the controlled weir of the spillway can also be used as outlet works to drain the lake.

A 72-inch diameter reinforced concrete pipe transversely penetrates the dam and is used as discharge culvert for both the spillway and outlet works.

A sheet pile cut-off wall is located within the embankment for a portion of its length. The cutoff wall is tied into steel sheet piling and also tied into timber piling around the spillway.

Two separate paved roadways are located on the dam crest. Depressed areas are located in the dam crest at each end to serve as overflow during periods of high water levels.

Having an overall crest length of 300 feet, the embankment has a top width of 43 feet and upstream and downstream slopes of 1.5 to 1 and 1 to 1 respectively. The spillway has dimensions 15 feet by 15 feet and a total weir length

of 45 feet. The spillway crest elevation is 40.6 while the dam crest elevation is 44.1. The depressions in the north and south ends of the embankment have low point elevations of 43.6 and 43.8 respectively.

The spillway crest lies 3.5 feet below the crest of the dam and 13.5 feet above the invert of the downstream end of the spillway discharge culvert.

The outlet works sluice in the upstream wall of the spillway has dimensions 3 feet by 3 feet and the stoplogs serving as regulating gate have a width of 4.7 feet.

b. Location

Timber Lake Dam, also known as Lower Birchwood Dam, is located in the Township of Medford, Burlington County, New Jersey. Separating Oakwood Lake from Timber Lake, it impounds the latter which lies in a residential area of Medford Township. (Note: Timber Lake is also referred to as Lower Birchwood Lake.) Water outflowing from the dam passes through Oakwood Lake and then into Haynes Creek. Access to the dam is provided by the local road located on its crest.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams", published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

	Impoundment	
Category	Storage (Ac-ft)	Height (Ft)
Small	< 1000 and ≥ 50	< 40 and ≥ 25
Intermediate	≥ 1000 and $< 50,000$	≥ 40 and < 100
Large	$\geq 50,000$	≥ 100

HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (no permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than few	Excessive (Extensive community, industry or agriculture)

The characteristics of Timber Lake Dam are:

Storage = 140 acre-feet

Height = 18.8 feet

Potential Loss of Life: Approximately 30 homes along Oakwood Lake downstream of dam. Approximately 5 homes could be inundated by SDF breach outflow.

Potential Economic Loss: Bridge and dam approximately one mile downstream of dam. Homesites along Oakwood Lake.

Therefore, Timber Lake Dam is classified as "Small" size and "High" hazard potential.

d. Ownership

Timber Lake Dam is owned and operated by Birchwood Lakes Colony Club, 55 S. Lakeside Drive, Medford, N. J. 08055.

e. Purpose of Dam

The purpose of the dam is the impoundment of a recreational lake facility for a residential development.

f. Design and Construction History

Timber Lake Dam reportedly was originally used in the 1880's to impound cranberry bogs. The dam was reconstructed in the 1930's and failed as the lake was filled. Following repairs, the lake was filled again resulting in a second failure. In 1954, the dam was again reconstructed.

This reconstruction successfully impounded the lake and has remained essentially intact until present with the exception of a widening of the embankment in 1966 to a accommodate a new sanitary sewer line. Plans for the dam and appurtenances were prepared by B. Harold Wills in 1954 and the dam was reconstructed in 1955 by the Hill Construction Co.

g. Normal Operational Procedures

The dam and appurtenances are maintained by the Birchwood Lake Colony Club. There is no fixed schedule of maintenance; repairs are made as the need arises.

The outlet works is used to drain the lake for lake maintenance purposes and during times of high water level to attenuate flooding conditions.

1.3 Pertinent Data

a. Drainage Area - 9.3 square miles

b. Discharge at Damsite

Maximum known flood at damsite	Unknown
Outlet works at pool elevation	123 c.f.s.
Diversion tunnel low pool outlet at pool elevation	N.A.
Diversion tunnel outlet at pool elevation	N.A.
Gated spillway capacity at pool elevation	N.A.
Gated spillway capacity at maximum pool elevation	N.A.

Ungated spillway capacity at top of dam	425 c.f.s.
Depressed areas in crest of dam	16 c.f.s.
Total spillway capacity at top of dam	441 c.f.s.

c. Elevation (Feet above MSL)

Top of Dam	44.1
Maximum pool-design surcharge	46.23
Full flood control pool	N.A.
Recreation pool	41±
Spillway crest	40.6
Upstream portal invert diversion tunnel	N.A.
Stream bed at centerline of dam	29.8
Maximum tailwater	38± (Estimated)

d. Reservoir

Length of maximum pool	3000 feet
Length of recreation pool	3000 feet (scaled)
Length of flood control pool	N.A.

e. Storage (Acre-feet)

Recreation pool	55 acre-feet
Flood control pool	N.A.
Design Surcharge	234 acre-feet
Top of dam	140 acre-feet

f. Reservoir Surface (Acres)

Top of dam	43 acres (Estimated)
Maximum pool	60 acres (Estimated)
Flood control pool	N.A.
Recreation pool	17 acres
Spillway crest	17 acres

g. Dam

Type	Earthfill
Length	300 feet
Hydraulic Height	18.8 feet
Side slopes - Upstream	1.5 horiz. to 1 vert.
- Downstream	1 horiz. to 1 vert.
Zoning	Unknown
Impervious core	Timber and steel sheet piles
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Drop Inlet
Length of weir	45 feet
Crest elevation	40.6
Gates	N.A.
Upstream channel	N.A.
Downstream channel	72" RCP Discharge Culvert

j. Regulating outlets

3' x 3' sluice controlled by timber stoplogs.

SECTION 2: ENGINEERING DATA

2.1 Design

No plans or calculations pertaining to the original dam could be obtained. However, information generated at the time of the construction of the present dam is available. The following plans are available:

1. Plans titled "Construction Details, Timber Lake Dam No. 1" (one sheet), prepared by B. Harold Wills, dated May 15, 1952.

2. Plan titled "Layout Plan for Proposed Development, Formerly Braddocks Bogs on Jackson Road," prepared by Earl Higginbotham, dated April, 1952.

No calculations are available for the dam and spillway constructed in 1954 nor are any plans or calculations available for the embankment widening in 1966. A summary of hydraulic and hydrologic analyses as well as a description of core wall layout is contained in the New Jersey State Water Policy Commission "Report on Dam Application" dated June 21, 1952. See paragraph 6.1.b.

A soil description of the dam site issued by the Hill Construction Co. on April 29, 1952 indicated the following strata: white sand for 5 feet; black heavy vegetable matter for 6 feet; then begin white clay.

2.2 Construction

Two inspection reports compiled in 1952 indicated that construction on the dam was progressing satisfactorily. An inspection report dated June 17, 1954 reported that construction had been completed in accordance with the approved plans.

2.3 Operation

No records of operation of the lake or dam are available. No inspection reports subsequent to construction of the dam are available.

2.4 Evaluation

a. Availability

Available engineering information is limited to that which is on file at the NJDEP. The NJDEP file contains copies of plans, correspondence and inspection reports. The file is available for inspection at the offices of the Bureau of Flood Plain Management, 1474 Prospect Street, Trenton, N. J.

b. Adequacy

The available information forms a fair description of the subject dam and is of limited assistance in the performance of a Phase I evaluation. The available copy of construction details is in poor condition severely limiting its value in describing the dam. A list of absent information is included in paragraph 7.1.b.

c. Validity

Most information that could be verified is valid within a reasonable allowance for error. Data found in the NJDEP file that is at variance with the findings of this inspection and evaluation are noted in paragraph 7.1.b.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspection of Timber Lake Dam was performed on December 19, 1978 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

1. The embankment of the dam, appurtenant structures and adjacent areas were examined.
2. The embankment and accessible appurtenant structures were measured and key elevations determined by hand level.
3. The embankment, appurtenant structures and adjacent areas were photographed.

b. Dam

The dam embankment appeared to be generally uniformly aligned horizontally with a slight curve at the south end. The vertical alignment is generally level with slight depressions noted at each end of the embankment. The bottom of the depression at the north end is approximately 0.5 feet below the dam crest while the bottom of the southerly depression lies approximately 0.3 feet below the dam crest. No slope protection was observed on the downstream face of embankment in the areas of the depressions.

The embankment is generally sandy with grass covering most surfaces. A significant quantity of low brush and

trees is found on both the upstream and the downstream faces. A road with two separate paved lanes lies on the dam crest. Significant erosion was observed on the downstream face in the vicinity of the spillway discharge culvert. In addition, riprap was observed on the downstream face at the waterline of Oakwood Lake. The extent of riprap appeared to be insufficient to be effective as slope protection. The downstream toe of embankment is submerged for part of its length by tailwater which consists of Oakwood Lake. No evidence of cracking, settling or seepage was noted in the dam nor were any animal holes observed.

The generalized soils description of the dam site consists of shallow surface alluvial deposits of interbedded sand and silty sand with some intermixed gravel deposited during the Quaternary Period and shown as the Cape May formation on the Geologic Map of New Jersey prepared by Lewis and Kummel. The shallow surface soils are underlain by alluvial deposits of stratified silty sand interbedded with irregular layers of sandy silt, with local layers of clayey sand deposited during the Tertiary Period and known as Kirkwood Sand. The lake basin contains significant surficial organic material, silt and sand with some clay. Borings performed prior to the reconstruction in 1954 indicated the presence of a layer of organic material. See paragraphs 2.1 and 6.1.b.

Bedrock is in excess of 100 feet below the ground surface.

c. Appurtenant Structures

The crest of the spillway appeared uniformly aligned although it was submerged by overflow at the time of

inspection. Water was flowing over the concrete weir section of the spillway and, therefore, the condition of much of the structure was not clearly observed. The steel grate platform and walkway covering the spillway was found to be structurally unsound and consequently dangerous.

The timber stoplogs comprising the outlet works could not be closely observed but appeared to be in satisfactory condition.

The spillway discharge culvert could be observed only at its inlet and outlet, and is almost completely submerged by tailwater at its outlet. The small portion of the culvert that could be observed indicated that the concrete is in satisfactory condition. There is no headwall at the outlet.

d. Reservoir Area

Timber Lake is long and narrow, averaging approximately 250 feet in width with an overall length in excess of 1/2 mile. It is located in a residential area of Medford Township.

Located in a topographically flat to moderately sloping area, Timber Lake is part of a series of dammed lakes discharging from one to the other. Several of the lakeside homesites include docks and other lake related structures.

e. Downstream Channel

The spillway discharges directly into Oakwood Lake. No significant obstructions to the downstream flow were

observed. In the vicinity of the subject dam, Oakwood Lake is approximately 100 feet wide with steep banks. Homes lie along both sides of the lake at an average grade of eight to ten feet above the lake level. Farther downstream, the lake is narrower and some homes are as low as six feet above the water level.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Timber Lake is regulated naturally by discharge over the concrete walls of the drop-inlet spillway of Timber Lake Dam. Periodically, the lake is lowered for maintenance by removing stoplogs in the outlet works located at the upstream end of the spillway. The time required to lower the lake to one half its normal level reportedly is three to four days.

Stoplogs reportedly are removed at times of intense storms in order to attenuate flood water level.

4.2 Maintenance of the Dam

There is no program of regular inspection and maintenance of the dam and appurtenant structures. Maintenance is performed on an "as needed" basis.

4.3 Maintenance of Operating Facilities

Maintenance of operating facilities such as outlet works is performed on an "as needed" basis. Approximately six years ago, the slide gate originally installed in 1954 was removed and stoplogs installed in its place. The stoplogs were replaced during 1978.

4.4 Description of Warning System

Reportedly, telephone communication is maintained between persons responsible for dams in the Medford Lakes area and the Civil Defense representatives in neighboring Medord Lakes Borough.

4.5 Evaluation of Operational Adequacy

The operation of the dam, including the warning system in effect, has been successful to the extent that the dam has not been overtopped since the present dam was constructed in 1954.

Although maintenance documentation is poor, the adequacy of the maintenance program for the dam appears to have been good. Areas of maintenance that have not been adequately performed are:

1. Trees and brush allowed to grow on embankment.

2. Erosion allowed to develop in vicinity of spillway discharge culvert.

3. Hazardous steel grate covering spillway not replaced.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The intensity of storm water runoff that the spillway should be able to handle is based on the size and hazard classification of the dam. This runoff intensity, called the spillway design flood (SDF), is described in terms of frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams," published by the U.S. Army Corps of Engineers, the SDF for Timber Lake Dam falls in a range of 1/2 PMF to PMF. In this case, the low end of the range, 1/2 PMF, is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The SDF hydrograph for Timber Lake Dam was assumed to be equal to the outflow hydrograph for Birchwood Lake Dam which is directly upstream of Timber Lake. The outflow hydrograph for Birchwood Lake Dam was computed by assuming that the dam would be overtopped by a storm equivalent to 1/2 PMF.

Computation of the inflow hydrograph for Birchwood Lake, as well as the routing of the SDF through Birchwood Lake and through Timber Lake was performed by the HEC-1-DB Flood Hydrograph computer program. The inflow unit hydrograph for Birchwood Lake was developed by use of Clark's coefficients. Detailed hydrologic computations

and computer output are contained in Appendix 4. The peak SDF inflow for Timber Lake Dam was computed to be 2591 c.f.s.

Discharge capacity for Timber Lake Dam was computed by considering free discharge over the walls of its drop-inlet spillway. In addition, minor flows over the two depressions in the dam crest were considered for lake stages within 0.5 feet of the dam crest. The spillway was assumed to have the combined characteristics of a broad crested weir with breadth equal to 1 foot (concrete weir) and a sharp crested weir (stoplogs). The combined discharge of the two weirs, together with discharge over the depressions in the dam crest was computed to be 441. c.f.s. with the lake water level equal to the dam crest elevation.

A routing of the SDF through Timber Lake resulted in an overtopping of the dam crest by a depth of 1.8 feet for a duration of 34 hours. A dam breach analysis was then performed using a trapezoidal breach of 92 feet top length. The peak breach outflow was computed to be 4740 c.f.s.

The breach analysis indicates that dam failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist without overtopping failure. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

The dam reportedly has not been overtopped since its construction in 1954. Reportedly, the highest water level in Timber Lake occured about six years ago when a dam upstream of Birchwood Lake failed. At that time, the level of Timber Lake rose to within 1.5 feet of the crest of Timber Lake Dam.

c. Visual Observations

No evidence was found at the time of inspection that would indicate that the dam had been overtopped.

d. Overtopping Potential

As indicated in paragraph 5.1.a, a storm of magnitude equivalent to the SDF which causes a breach in Birchwood Lake Dam would cause overtopping of the Timber Lake Dam to a height of 1.8 feet. Computations indicate that the dam can pass approximately 10% of the PMF.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The embankment appeared, at the time of inspection, to be structurally stable with no evidence of cracks, displacement, differential settlement or seepage.

b. Design and Construction Data

Analysis of structural stability and construction data for the embankment and spillway structure are not available.

A narrative statement contained in the New Jersey State Water Policy Commission "Report on Dam Application" dated June 21, 1952 provides some limited information regarding design data for the subject dam. According to the report, the most probable reason for the prior breaches of the dam was the failure of cut-off sheeting to penetrate the layer of organic material lying beneath the dam. Reconstruction was to include a cut-off wall driven across the gap created by the breach and tied into steel sheet piling and also tied into timber piling around the new spillway.

Design and construction data is also contained on drawings prepared by B. Harold Wills in 1954.

c. Operating Records

No operating records are available for the dam. The water level of Timber Lake is not monitored.

d. Post Construction Changes

Since Timber Lake Dam was reconstructed in 1954, the following changes have been made in the dam and appurtenances:

1. The slide gate and operating mechanism was replaced by stoplogs.

2. The embankment was widened in 1966 in order to accommodate the installation of a sanitary sewer main.

3. At the time that the embankment was widened, the spillway discharge culvert was lengthened. The additional length of culvert was apparently constructed with the same type and cross section as that existing prior to the embankment widening. Consequently, loss of soil around the joint between the two lengths of culvert is not anticipated.

e. Seismic Stability

Timber Lake Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if stable under static loading conditions. Timber Lake Dam appeared to be stable under static loading conditions at the time of inspection.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Timber Lake Dam is considered to be inadequate. The spillway is not able to pass the SDF designated for the dam without an overtopping of the dam, and failure due to overtopping would not significantly increase the potential for loss of life downstream from that which would exist without overtopping failure.

The structural integrity of the dam appears to be adequate based on field inspection. No reported nor written evidence was found that would contradict this assessment. However, a complete assessment of possible seepage is not possible at the present time due to the submerged condition of part of the downstream toe of the dam.

b. Adequacy of Information

Information sources for this study include: 1) field inspection, 2) plans and correspondence in NJDEP files, 3) USGS quadrangle sheet, 4) aerial photography from Burlington County and 5) consultation with maintenance and operation personnel for the dam and officials of Medford Township. The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some data not available are as follows:

1. Stream and lake elevation gauging records.
2. Description of dam embankment fill materials
3. Inspection Reports subsequent to reconstruction.

Data contained in the NJDEP file at variance with the findings of this report are as follows:

1. Slopes of upstream and downstream faces of embankment, reported to be 2:1 each, were found to be 1.5:1 and 1:1 respectively.
2. Top width of dam, reported to be 22 feet, was found to be 43 feet.

Much of the information contained on the construction drawing by B. Harold Wills, such as sheet pile cut-off wall locations, could not be used due to the poor quality of the NJDEP file copy.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a and Appendix 4, the spillway is considered to be inadequate. Therefore, it is recommended that a qualified professional engineer be engaged soon to perform more accurate hydraulic and hydrologic analyses relating to the spillway capacity. The analyses should more accurately determine runoff characteristics of the watershed and should refine the discharge capacity of the spillway and the downstream channel capacity.

Based on the findings of these analyses, the dam and spillway should be modified to prevent overtopping of the dam resulting from a storm equivalent to the SDF. Some alternative remedial measures include the following:

1. Replace the spillway with a spillway having a greater effective weir length.
2. Construct a secondary spillway to augment the capacity of the existing spillway.
3. Create one or more detention impoundments upstream of Birchwood Lake Dam.

In addition to the measures outlined above, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1. The depressions in the dam crest should be filled to create a level crest and prevent channelization of any overflow.

2. Trees and brush on the dam embankment should be removed. All trees and brush should be cut at the ground surface in a way that will cause minimal disturbance to the embankment.

3. The concrete spillway should be thoroughly inspected and repaired as outlined below:

    a. Drain the lake to an elevation equal to the bottom of the stoplogs.
    b. Sandblast all concrete and apply an epoxy preservative coating to all surfaces.
    c. Pressure grout all major cracks and patch any observed spalls and eroded surfaces.

4. A detailed design for regrading the upstream and downstream embankment slopes should be prepared by a qualified professional engineer and the embankment should be regraded accordingly.

5. The steel grate and walkway covering the spillway should be replaced very soon.

The implementation of the above remedial measures will require proper detailed studies and design and the obtaining of applicable NJDEP approvals.

b. Maintenance

The owner of the dam should initiate, in the near future, a program of periodic inspection and maintenance, the complete records of which to be kept on file and made available to the public. A visual inspection of the dam and appurtenances by a qualified professional engineer should be made annually and reported on a standardized check-list form. Repairs should be made when required and the following maintenance should be performed annually: remove adverse vegetation from the embankment and fill and sod any eroded surfaces of the embankment. In addition, the lake should be lowered at least every five years at which time the lake should be cleaned and the submerged portions of the dam and spillway inspected and repaired.

c. Additional Studies

In order to properly assess the condition of the embankment in relation to possible seepage, the downstream water level should be lowered (by lowering Oakwood Lake) in order to expose the downstream toe of dam. When the toe is exposed, the area should be thoroughly inspected for evidence of seepage. This inspection and assessment should be performed in the near future by a qualified professional engineer.

A detailed topographic survey of the dam and area around the dam based on USGS datum should be undertaken by a qualified licensed land surveyor or professional engineer in the near future. The survey map should be related to existing construction drawings and should become part of the permanent record mentioned in paragraph 7.2.b.

PLATES

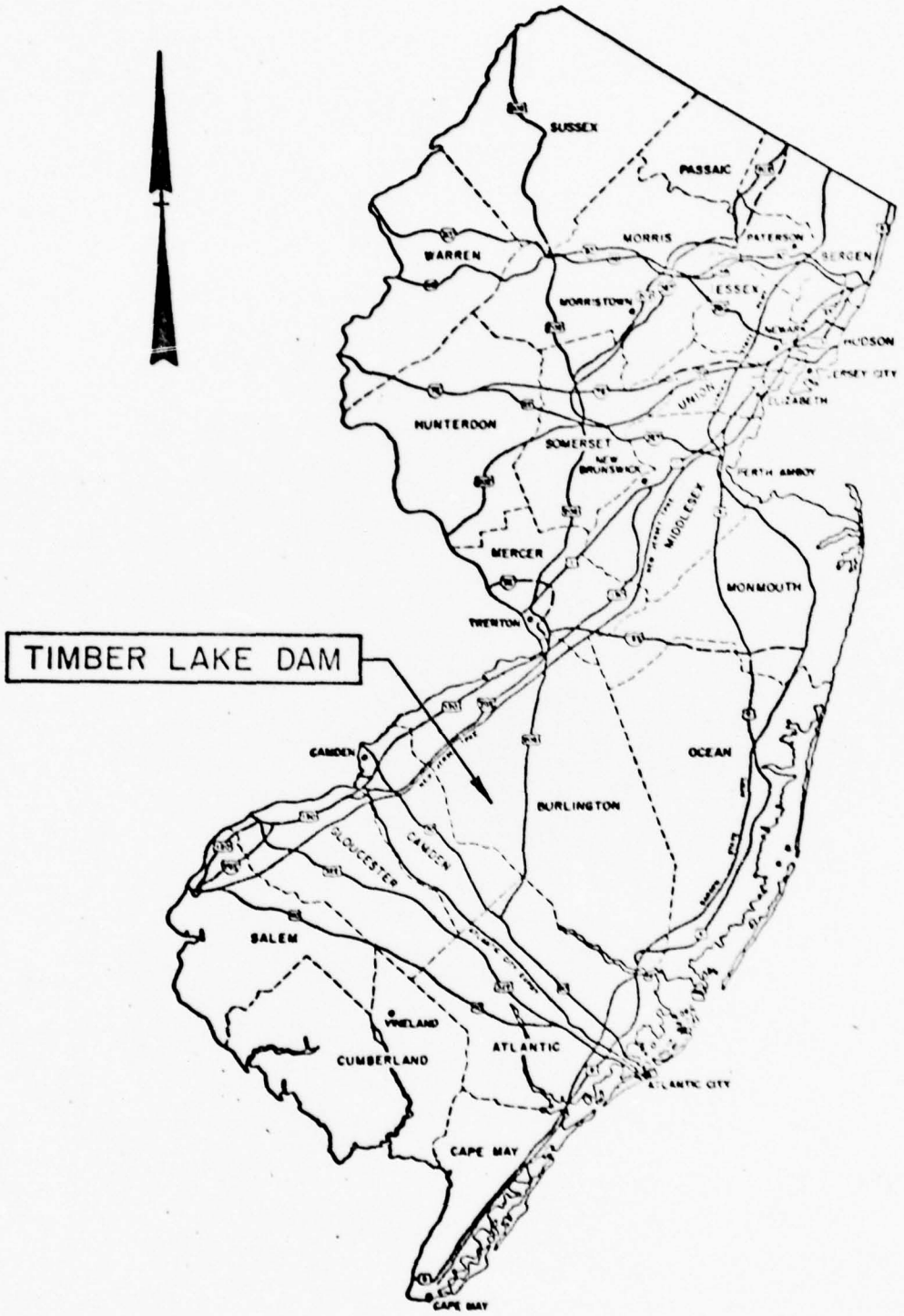


PLATE 1

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS KEY MAP TIMBER LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00416 / SCALE: NONE DATE: FEBRUARY, 1979

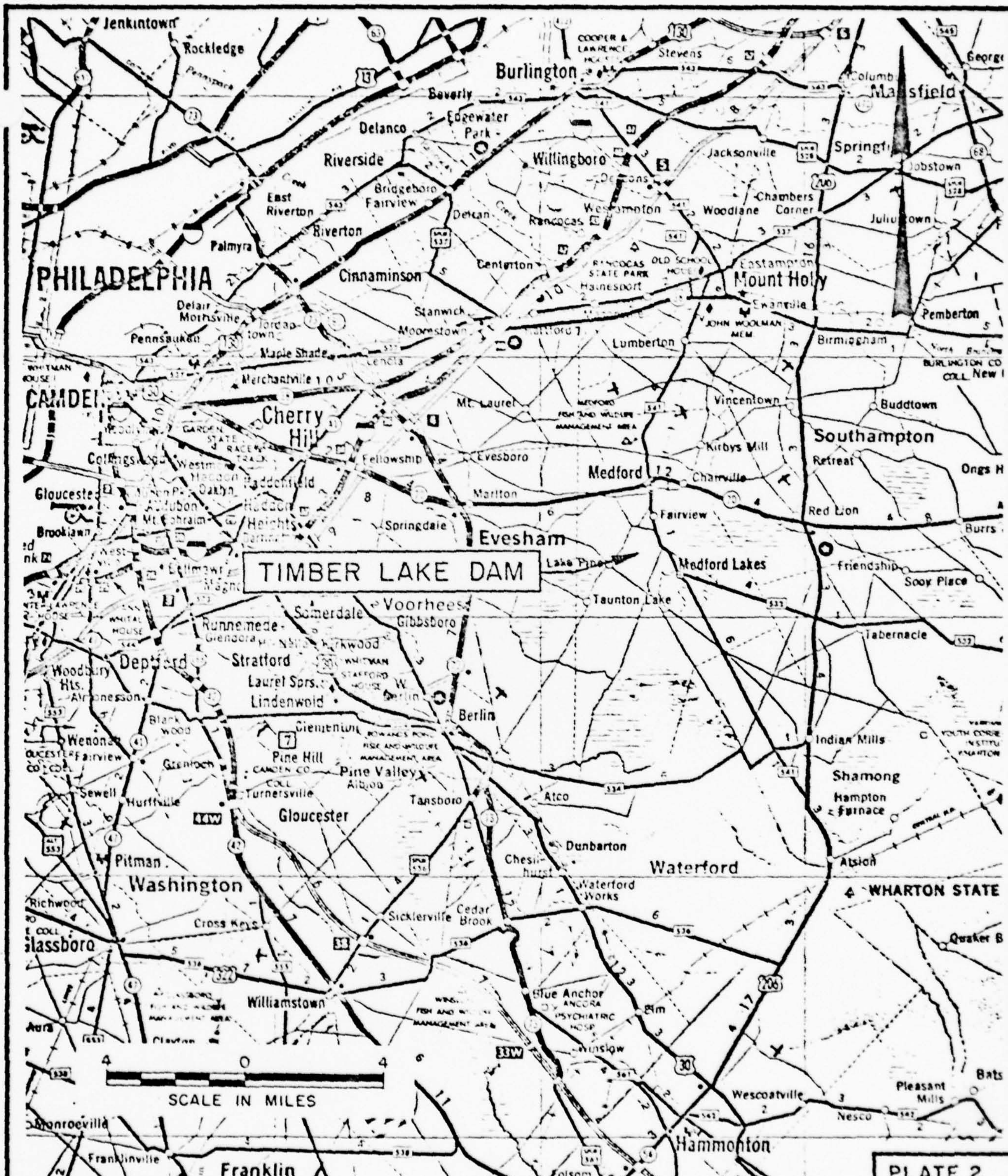
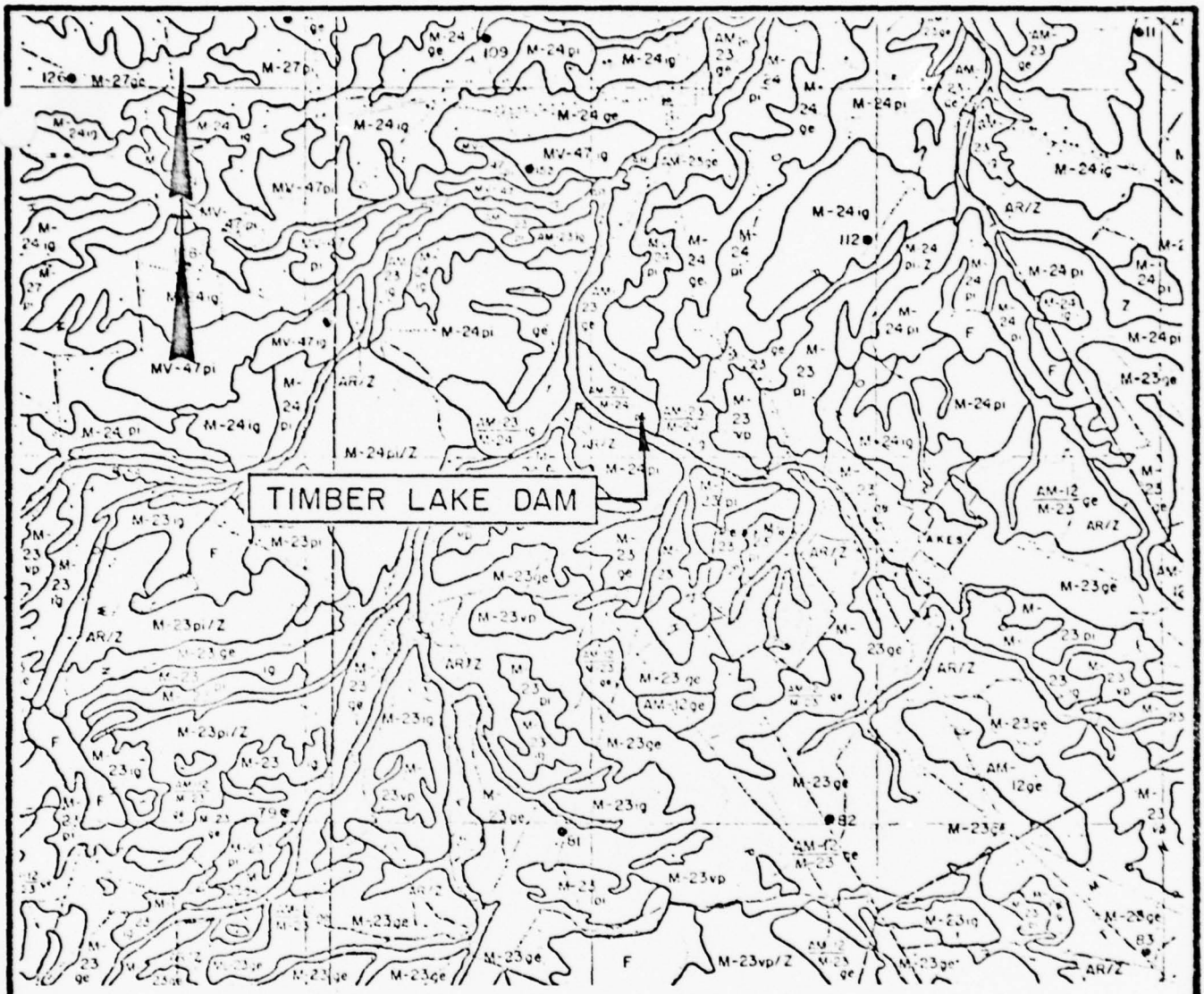


PLATE 2

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS **VICINITY MAP** TIMBER LAKE DAM	
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00416	SCALE: AS SHOWN
		DATE: FEBRUARY, 1979



Legend

AR/Z	Stratified, swampy alluvium
AM-23	Interbedded sand and silty sand with some intermixed gravel. (Cape May formation.)
M-24	Silty sand with interbedded, irregular layers of sandy silt. Local layers of clayey sand. (Kirkwood sand.)

Note: Information taken from Rutgers University Soil Survey of New Jersey, Report No. 20 and Geologic Map of New Jersey prepared by Lewis and Kummel.

PLATE 3

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

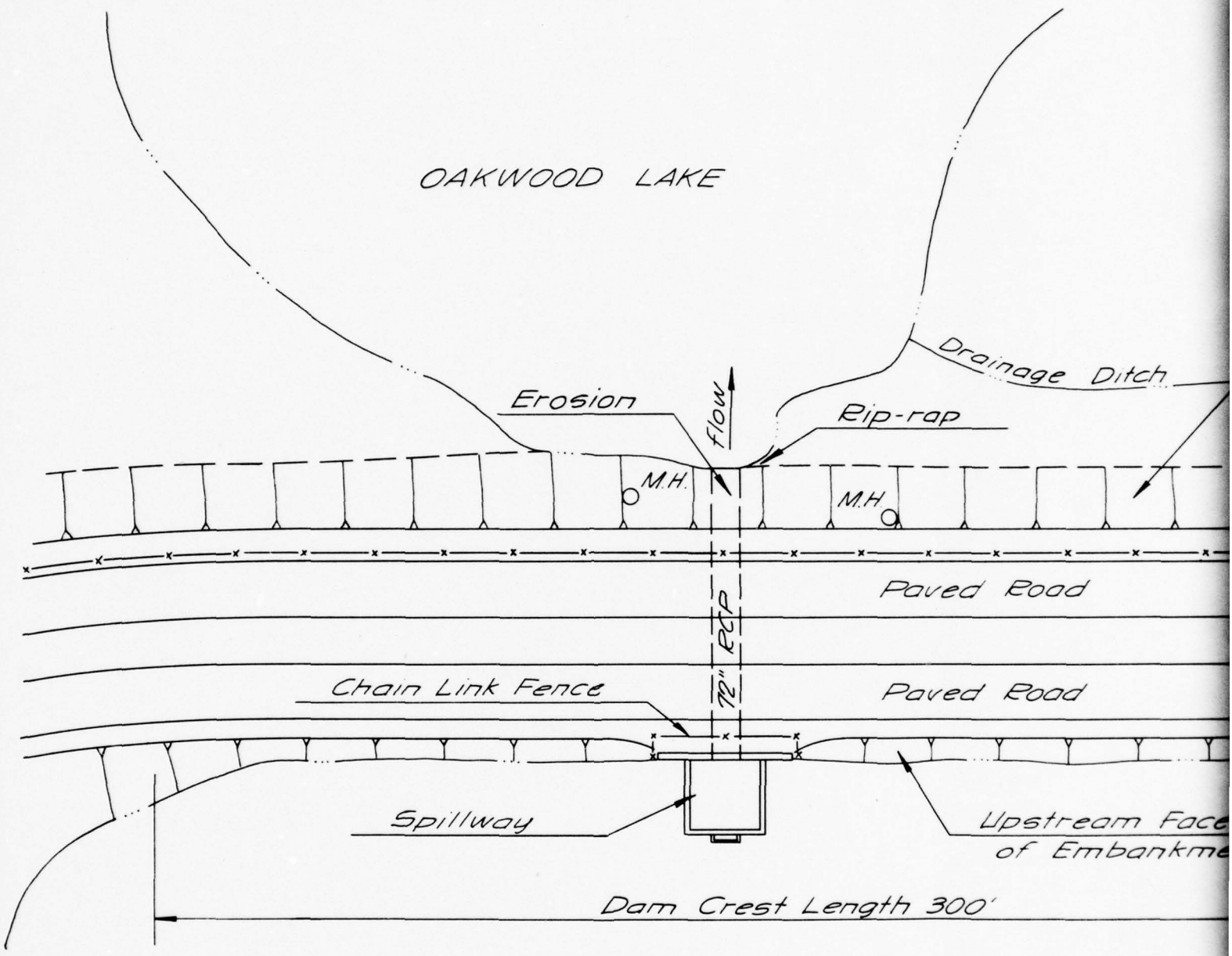
SOIL MAP

TIMBER LAKE DAM

I.D. N.J. 00416

SCALE: NONE

DATE: FEBRUARY, 1979



TIMBER LAKE
(LOWER BIRCHWOOD LAKE)

NOTE:
Information taken from plans prepared by B. Harold Willis dated May 15, 1952 and field inspection December 19, 1978.

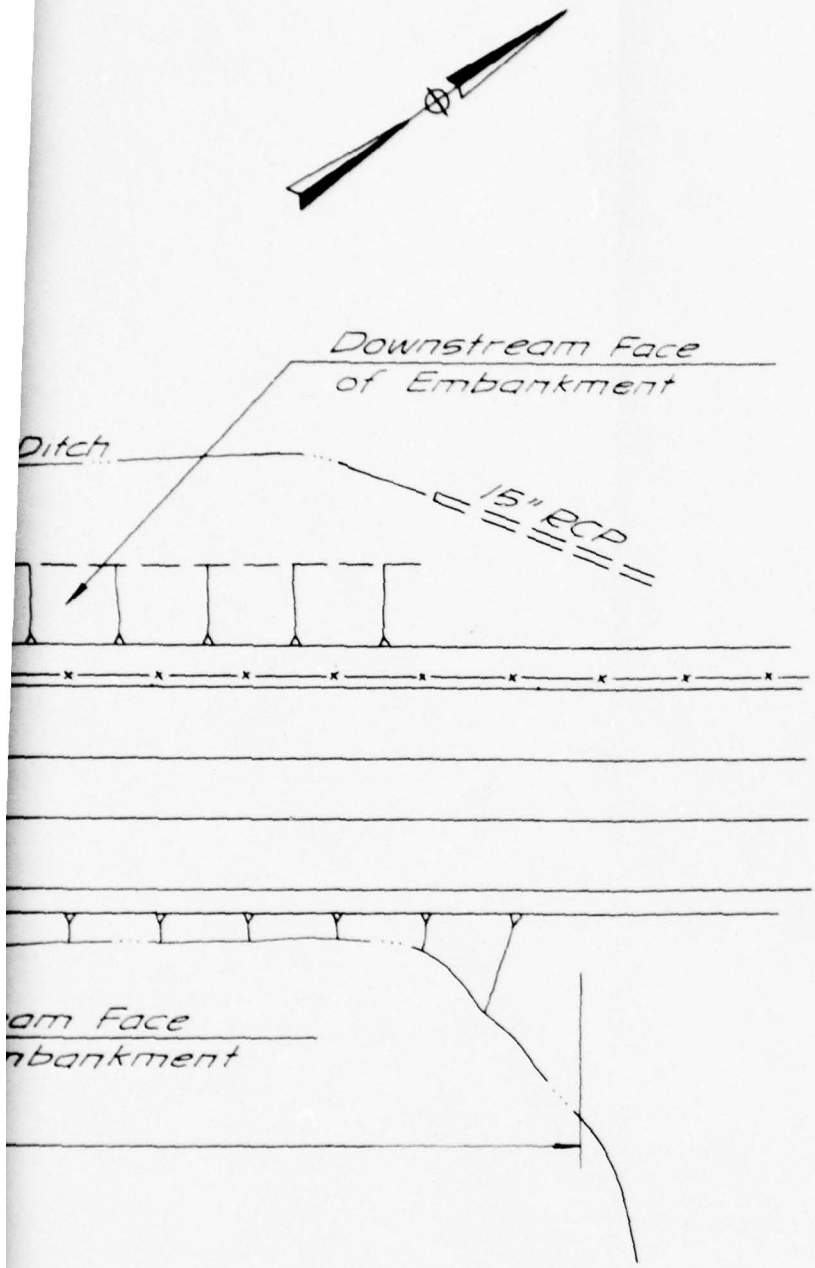


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PLATE 4

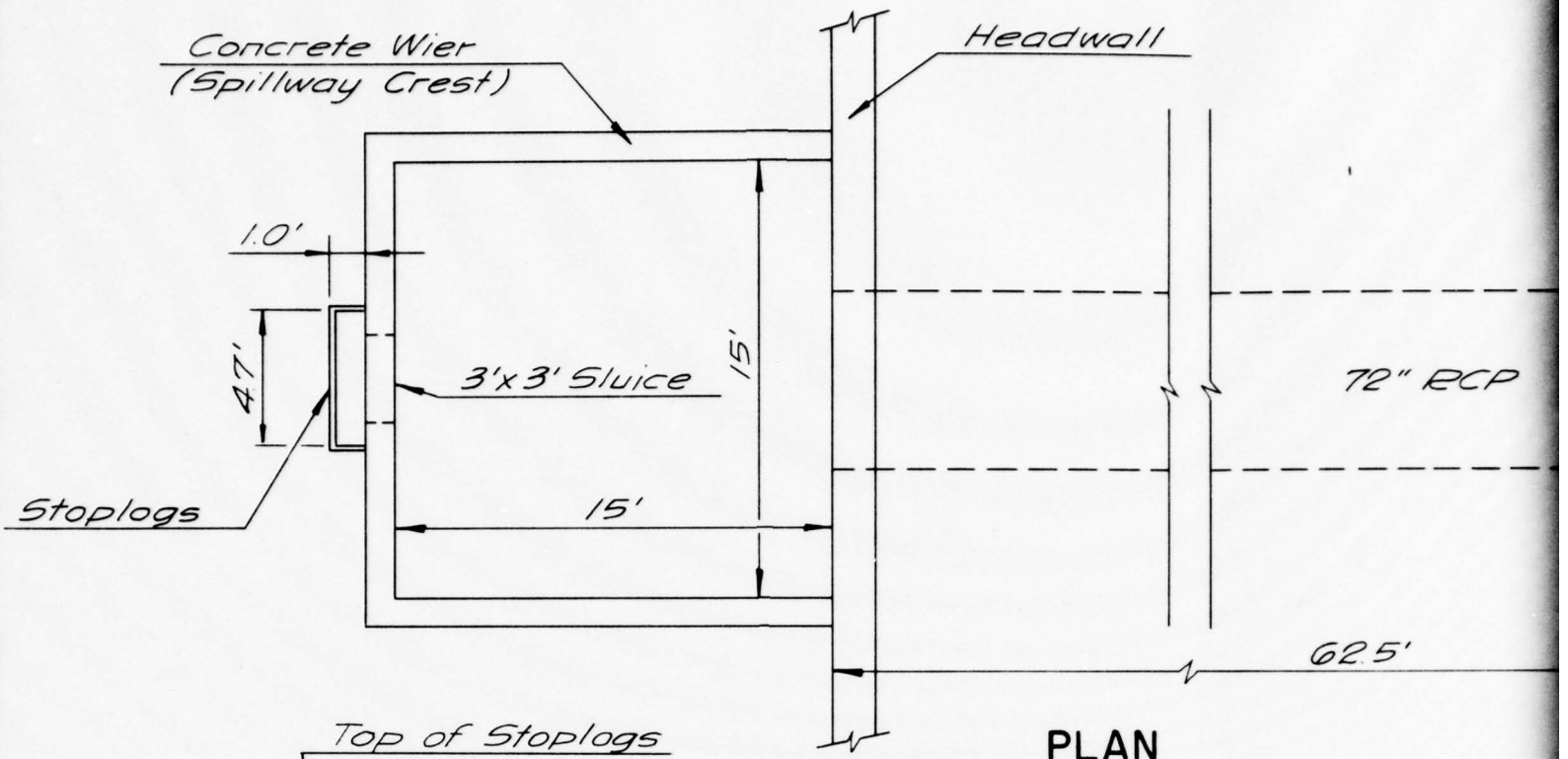
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

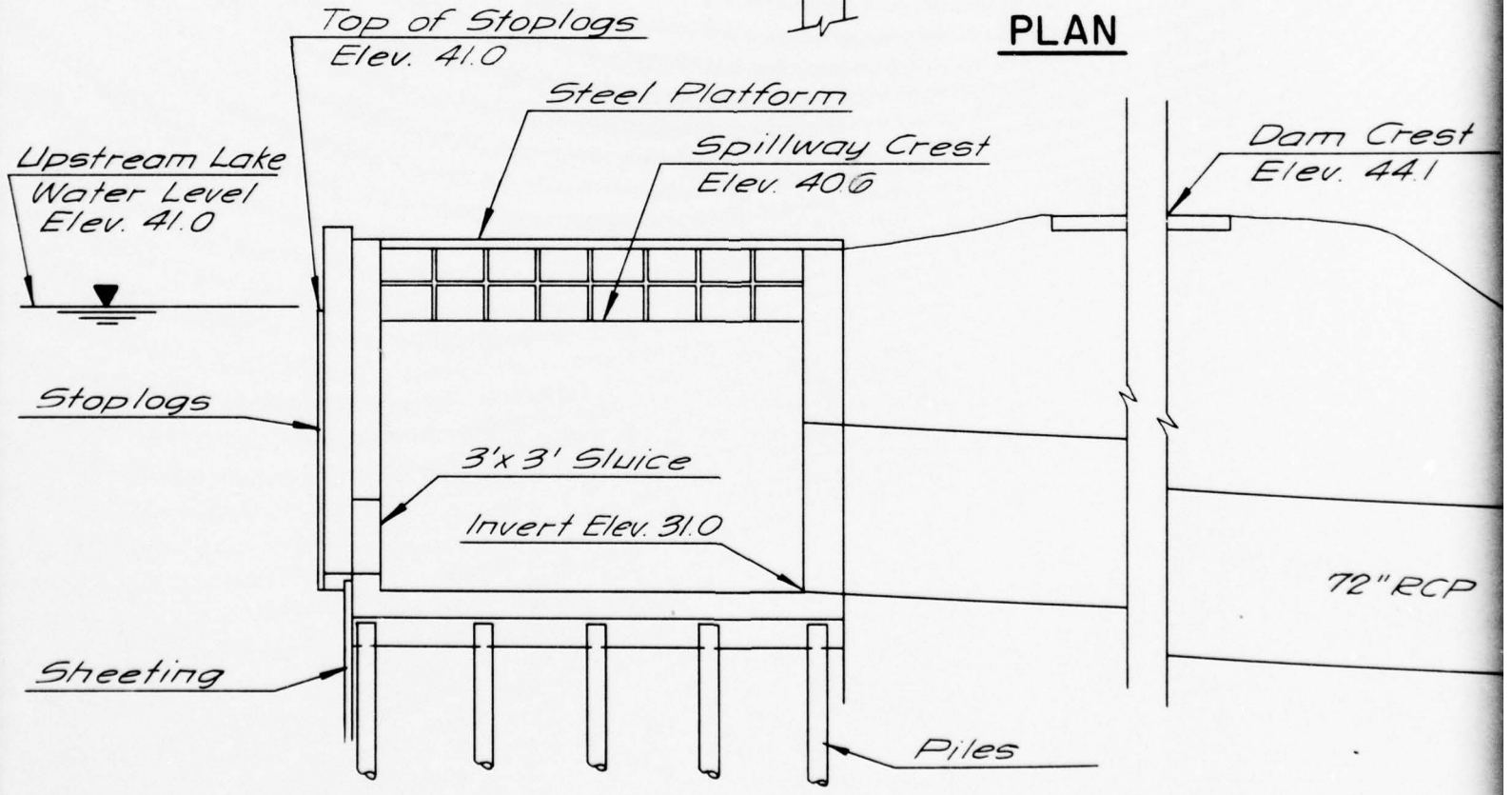
GENERAL PLAN

TIMBER LAKE DAM

I.D. N.J. 00416	SCALE: NOT TO SCALE
	DATE: FEBRUARY, 1979



PLAN



SECTION

NOTE:
Information taken from plans prepared by B. Harold Willis dated May 15, 1952 and field inspection December 19, 1978.

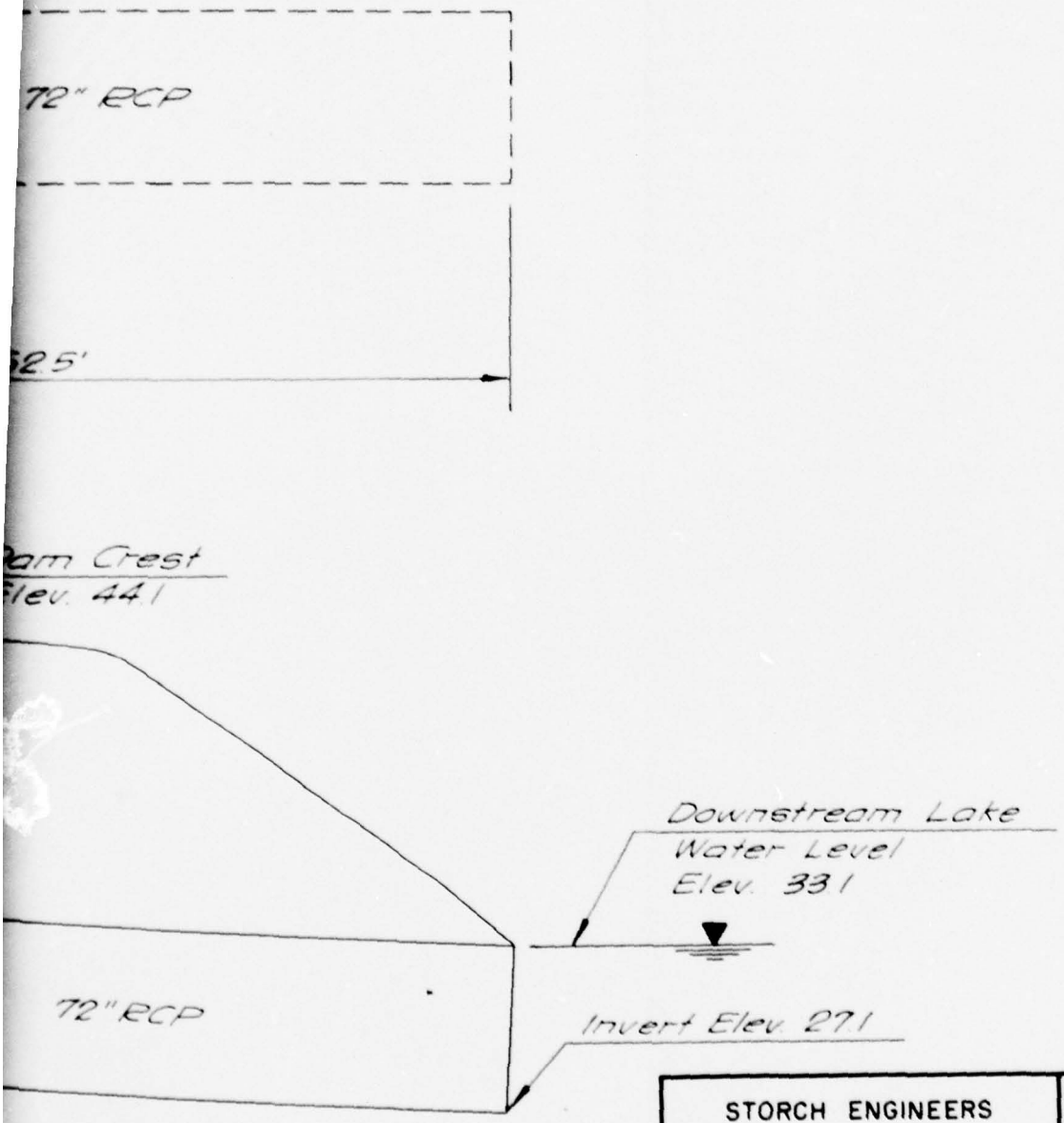


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PLATE 5

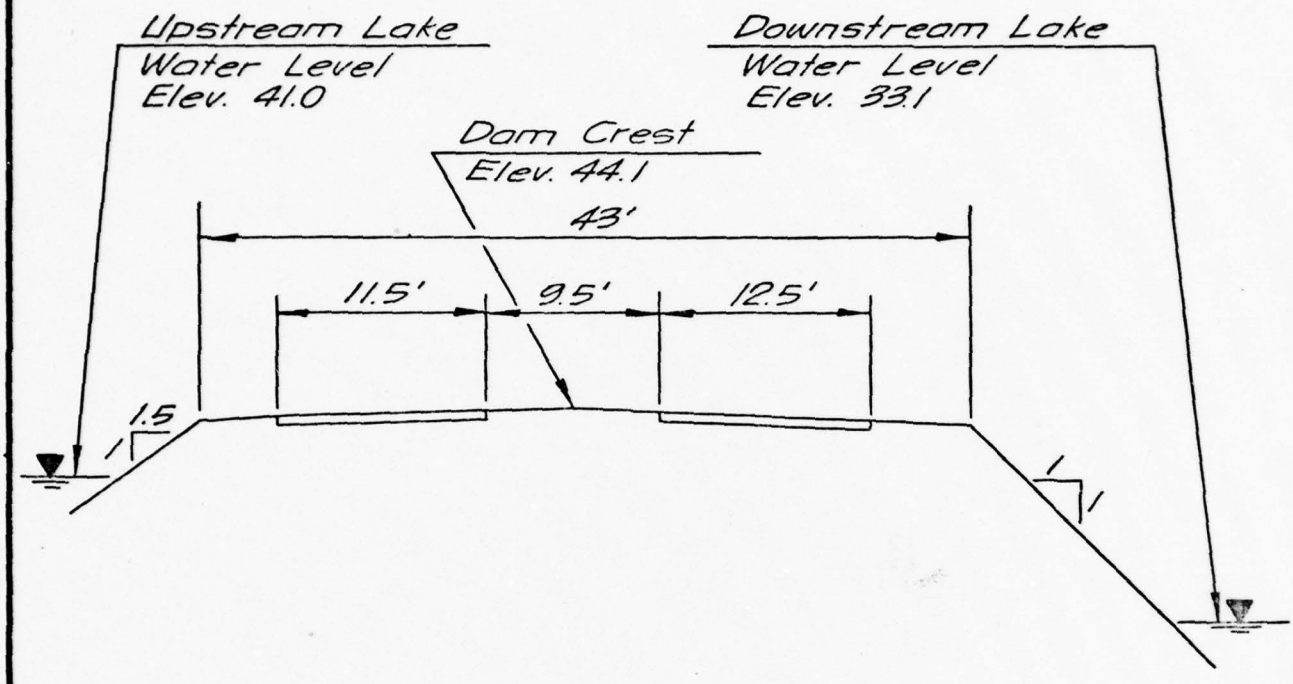
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

SPILLWAY PLAN & SECTION

TIMBER LAKE DAM

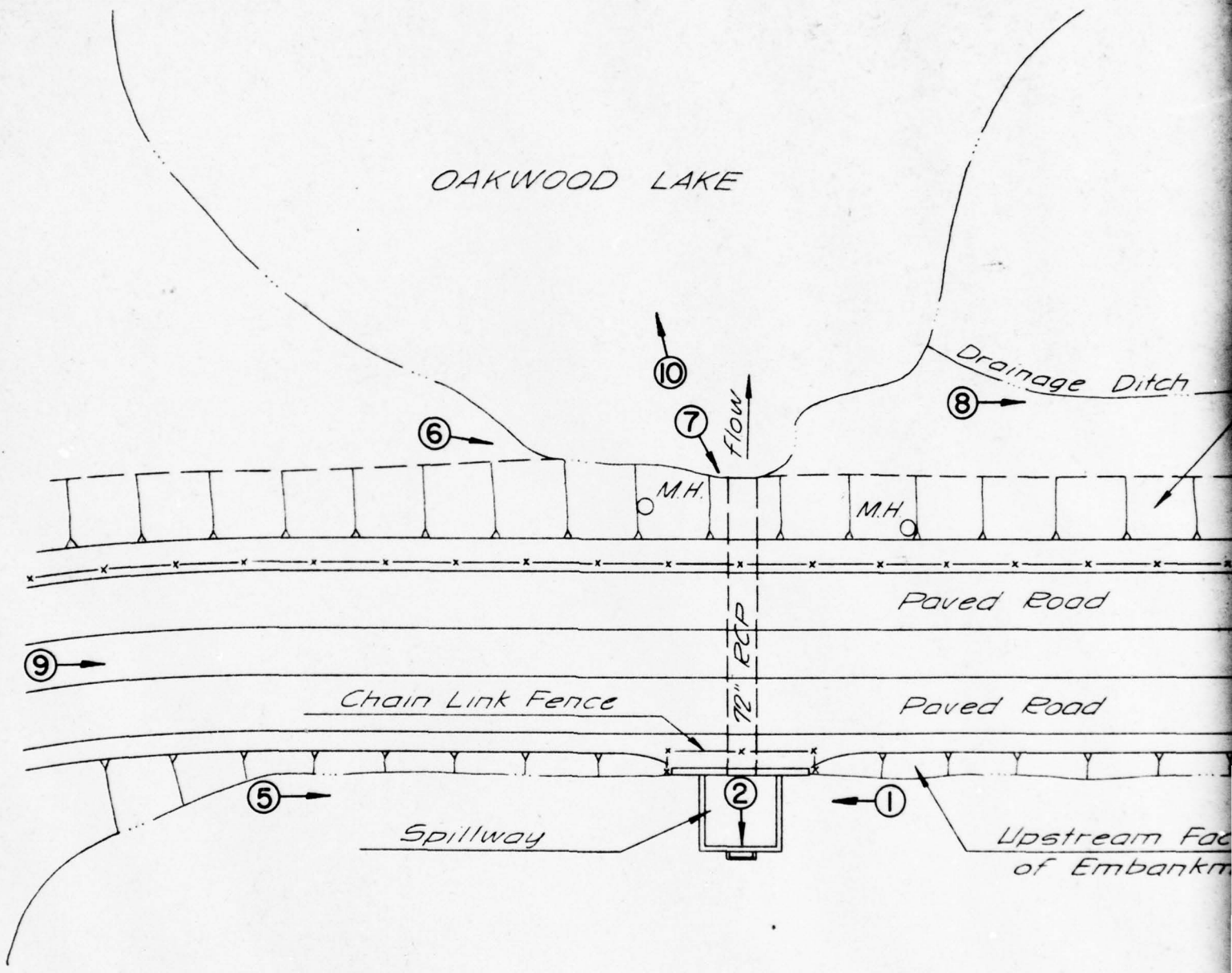
I.D. N.J. 00416	SCALE: NOT TO SCALE
	DATE: FEBRUARY, 1979



NOTE:
Information taken from field inspection December 19, 1979.

PLATE 6

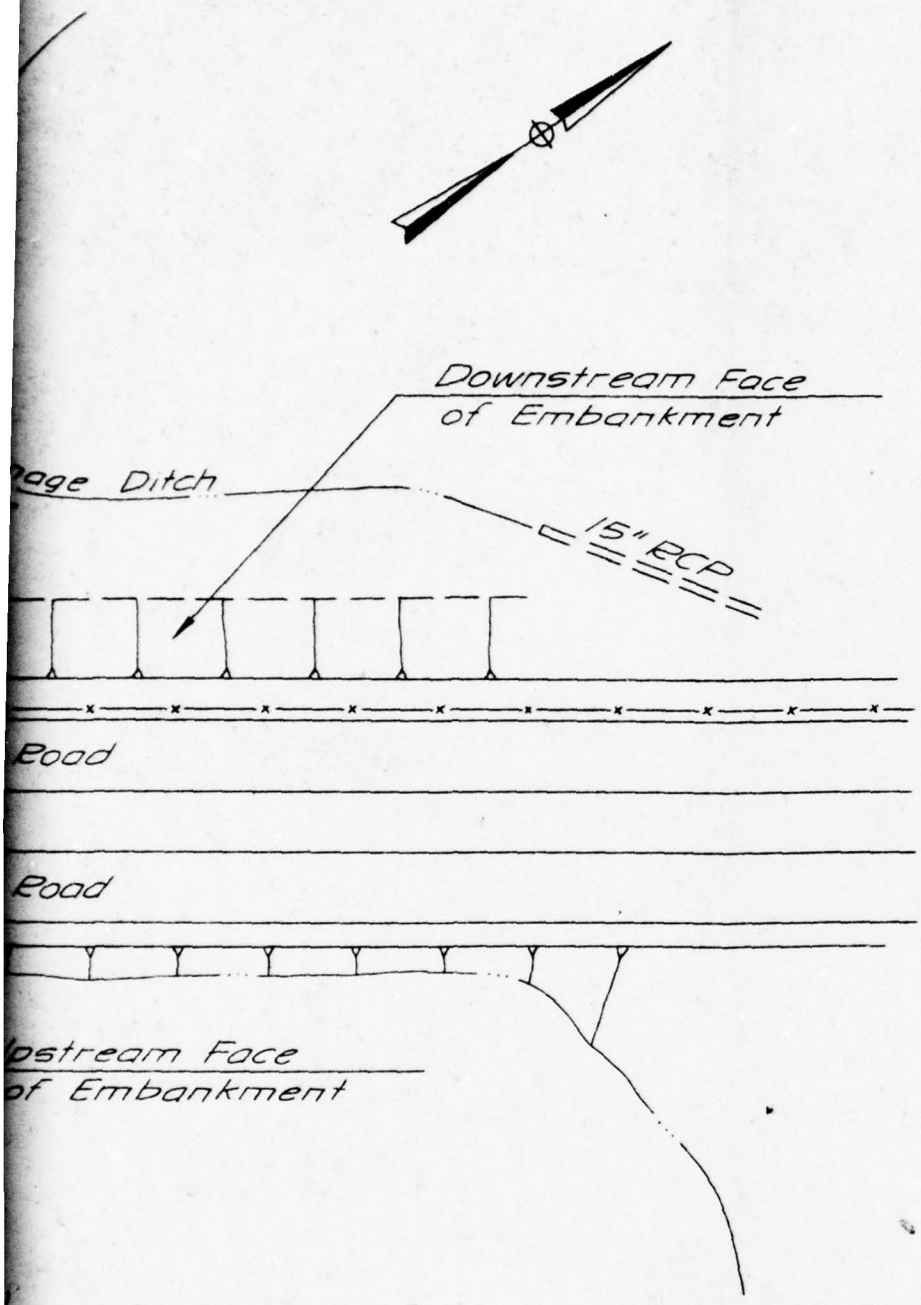
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS **DAM SECTION** TIMBER LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00416
	SCALE: NOT TO SCALE
	DATE: FEBRUARY, 1979



TIMBER LAKE
(LOWER BIRCHWOOD LAKE)

OVERVIEW

NOTE:
Information taken from plans prepared by B. Harold Willis dated May 15, 1952 and field inspection December 19, 1978.



2

PLATE 7

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

TIMBER LAKE DAM

I.D. N.J. 00416	SCALE: NOT TO SCALE
	DATE: FEBRUARY, 1979

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List
Visual Inspection
Phase 1

Name Dam Timber Lake County Burlington State N.J. Coordinators NJDEP

Date(s) Inspection 12/19/78 Weather P-Cloudy Temperature 40°F

Pool Elevation at Time of Inspection 41 M.S.L. Tailwater at Time of Inspection 33.1 M.S.L.

Inspection Personnel:

J. Gribbin R. McDermott

D. Buckelew

A. Miller

J.Gribbin Recorder

Present: Dick Strong, Birchwood Lake Colony Club.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE	N.A.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N.A.	
DRAINS	N.A.	
WATER PASSAGES	N.A.	
FOUNDATION	N.A.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N.A.	
STRUCTURAL CRACKING	N.A.	
VERTICAL AND HORIZONTAL ALIGNMENT	N.A.	
MONOLITH JOINTS	N.A.	
CONSTRUCTION JOINTS	N.A.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Significant erosion in downstream face at spillway discharge pipe.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Vert. alignment: level in center with depressions of approx. 0.5 foot at both ends. Horiz. alignment: straight	
RIPRAP FAILURES	Riprap observed at toe of downstream face at water line of downstream lake north of spillway discharge pipe. Quantity unsatisfactory.	Purpose and extent or originally constructed riprap unknown.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Embankment generally sandy with grass covering most surfaces. Some trees and low brush on upstream and downstream face.	Road with two paved lanes is located on crest of dam.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory	
ANY NOTICEABLE SEEPAGE	None. Observed	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed	
INTAKE STRUCTURE	Stoplogs at end of spillway structure	
OUTLET STRUCTURE		Water flows into spillway structure an then to spillway discharge culvert.
OUTLET CHANNEL	Same as spillway outlet channel	
EMERGENCY GATE	Stoplogs pulled by hand.	Function not observed.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	N.A.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	N.A.	
BRIDGE AND PIERS	N.A.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Concrete weir is formed by sides of box drop inlet. Condition satisfactory. Water flowing over entire weir length at time of inspection.	Conc. weir forms uncontrolled spillway Stoplogs for outlet works can also be used as controlled spillway.
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	6-foot diameter RCP through dam outletting into upstream end of Oakwood Lakes.	
BRIDGE AND PIERS	N.A.	
GATES AND OPERATION EQUIPMENT	Stoplogs same as outlet works.	Steel grate platform covering top of spillway drop inlet structurally unso and dangerous.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	N.A.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slopes range from 1% to 9%.	Land around lake entirely developed with homes. Docks are located at some of the homesites.
SEDIMENTATION	Not known.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No obstructions observed.	Downstream condition consists of lake with residential development along it shores.
SLOPES	Banks of lake are steep. Homes are approx. 8 ft. to 10 ft. above water surface.in vicinity of dam.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approx. 30 homes along downstream lake. Approx. 5 homes could be inundated by SDF breach outflow.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Plans titled "Construction Details, Timber Lake Dam No. 1" (1sheet), prepared by B. Harold Wills, dated May 15, 1952. (poor quality copy).
REGIONAL VICINITY MAP	Available
CONSTRUCTION HISTORY	Available (limited)
TYPICAL SECTIONS OF DAM	Not Available
HYDROLOGIC/HYDRAULIC DATA	Not Available
OUTLETS - PLAN	Available - Wills drawing
- DETAILS -CONSTRAINTS -DISCHARGE RATINGS	Not Available
RAINFALL/RESERVOIR RECORDS	Not Available

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS	Not Available
BORING RECORDS	Available (limited)
LABORATORY	Not Available
FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

ITEM	REMARKS
MONITORING SYSTEMS	Not Available
MODIFICATIONS	Not Available
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Available - New Jersey State Water Policy Commission "Report on Dam Application"
MAINTENANCE OPERATION RECORDS	Not Available

ITEM	REMARKS
SPILLWAY PLAN	
SECTIONS	Available - Wills drawings
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Not Available

APPENDIX 2

Photographs

PHOTO 1

SPILLWAY

PHOTO 2

STEEL PLATFORM OVER SPILLWAY.
STOPLOGS AT END OF SPILLWAY.

19 DEC. 1978

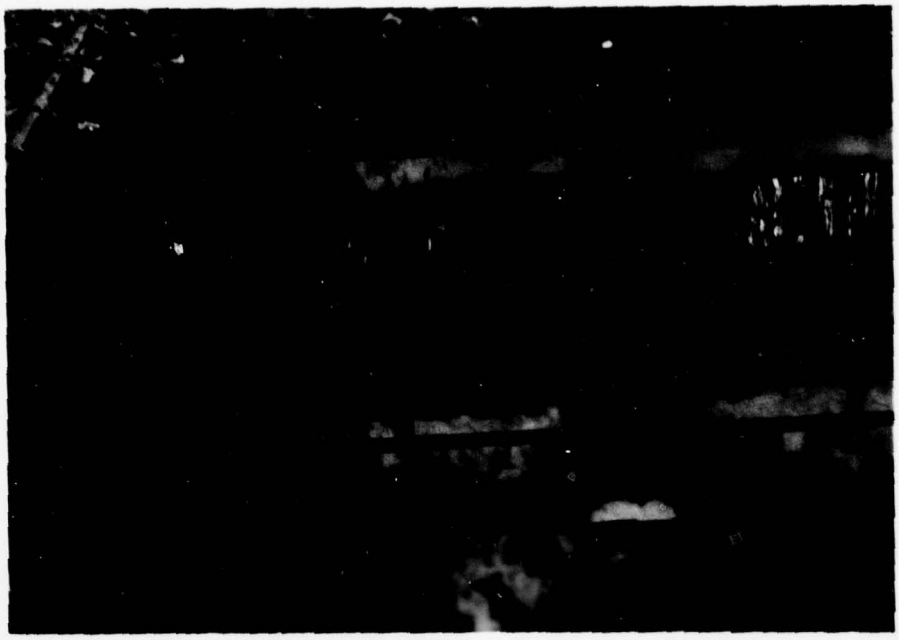


PHOTO 3

FLOWS OVER CONCRETE WEIR.
INLET FOR SPILLWAY DISCHARGE CULVERT.

PHOTO 4

TAILWATER AT TOP OF SPILLWAY
DISCHARGE CULVERT OUTLET.

19 DEC. 1978

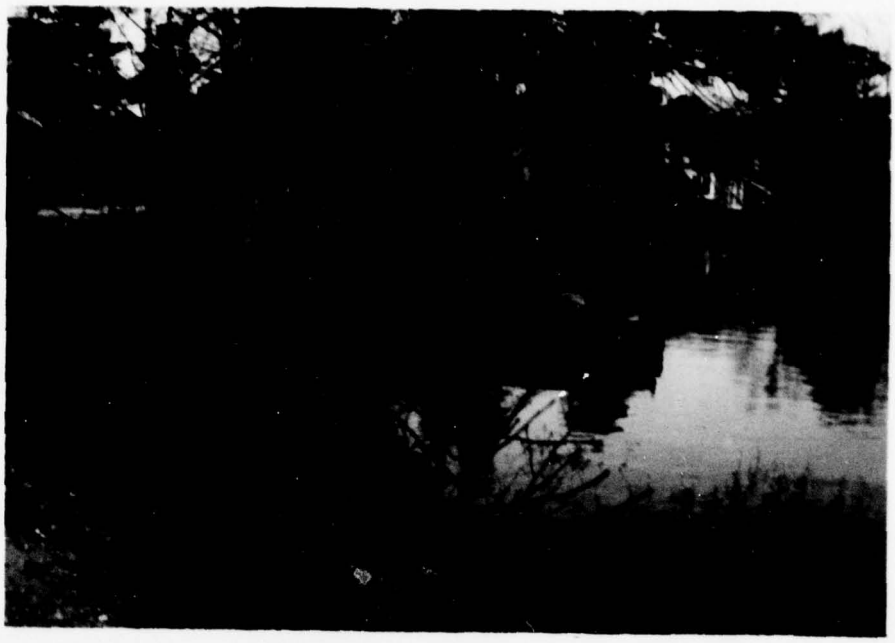


PHOTO 5

UPSTREAM FACE OF EMBANKMENT.

PHOTO 6

DOWNSTREAM FACE OF EMBANKMENT
SANITARY SEWER MANHOLES.

19 DEC. 1978

PHOTO 7

EROSION ON DOWNSTREAM FACE OF EMBANKMENT

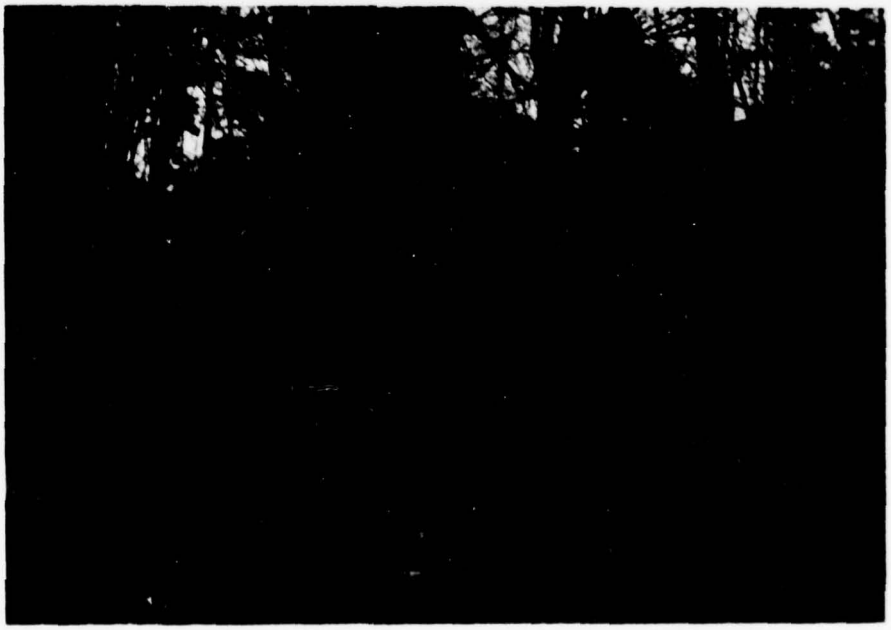


PHOTO 8

STORM DRAINAGE PIPE OUTLET

19 DEC. 1978

PHOTO 9

ROADWAY ON CREST OF DAM

PHOTO 10

DOWNSTREAM CHANNEL

19 DEC. 1978

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1/8 Urban, 7/8 wooded

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 41 (55 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 46.23

ELEVATION TOP DAM: 44.1 (field measured)

SPILLWAY CREST: Concrete weir & timber stoplogs

a. Elevation 40.6
b. Type uncontrolled overflow
c. Width 12 inches
d. Length Total 45 feet
e. Location Spillover Box inlet at upstream side of dam
f. Number and Type of Gates One gate - timber stoplogs 2.7 feet wide

OUTLET WORKS: Stoplogs discharging thru sluice in spillway wall

a. Type Gate
b. Location Upstream end of spillway
c. Entrance inverts Submerged
d. Exit inverts N.A.
e. Emergency draindown facilities: Remove stoplogs

HYDROMETEOROLOGICAL GAGES: None

a. Type N.A.
b. Location N.A.
c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake stage equal to top of dam) 441 c.f.s.

APPENDIX 4

Hydrologic Computations

STORCH ENGINEERS

Sheet 1 of 20

Project Timber Lake Dam

Made By RL Date 5-12-79

1132

Chkd By DAC Date 5-14-79

Size Classification

Surface area of impoundment as measured from 1" = 400' aerial photograph	16.5 Ac
Storage Capacity (Lake water level equal to dam crest)	140 acre-ft.
Height of dam	18.8 ft.
Size classification	Small

Hazard Potential Classification

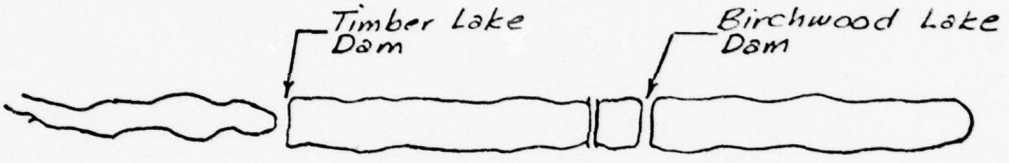
Number of inhabitable structures	30 (approx.)
Hazard potential classification	high
Recommended SDF	½ PMF

Hydrolgic Analysis

The Hydrograph from Birchwood Lake dam will be routed thru Timber Lake Dam by HEC-1-DB

HYDROLOGY

Inflow hydrograph was developed using outflow hydrograph for Birchwood Lake Dam.



Oakwood Lake Timber Lake D.A. = 9.3 sq. mi. Birchwood Lake D.A. = 8.5 sq. mi.

SDF for Timber Lake Dam is 1/2 PMF

Inflow hydrograph for Timber Lake Dam is equal to outflow hydrograph for 1/2 PMF routing through Birchwood Lake Dam.

On the following pages, parameters are developed to be used in the HEC-1-DB computer program in computing applicable hydrographs and routings.

STORCH ENGINEERS

Sheet 3 of 20

Project Birchwood Lake Dam 1132

Made By RL Date 3-7-79

Chkd By DMP Date 3-14-79

Precipitation

(Re "Design of Small Dams" USDI, 1973)

From fig 15 Zone 6

Probable Maximum Precipitation = 27 inches for 6 hr. duration and 10 sq. mi area

Duration (hrs)	% PMP
6	100
12	109
24	117

Runoff curve number

Hydrologic soil group A

Land use 1/8 urban 7/8 fair woodlot

Use initial infiltration 1.5 inches

constant infiltration 0.15 inch/hr.

Time of Concentration (T_c)

Clarks parameters supplied by Corps of Engineers:

$$\frac{R}{T_c + R} = .76$$

$$T_c + R = 21 \left(\frac{D.A.}{S}\right)^{.22} S_t^{.33} (1 + .3I)^{-.28}$$

$D.A. = 8.5$ sq. mi.

$S = 12.7$ ft./mi.

$S_t = 6\ \%$

$I = 11.1\ \%$

$T_c = 5.5$ hr.

$R = 17.6$ hr.

Main Channel Slope (s):

(Information taken from USGS quadrangle)

Length of main channel = 4.0 mi

10% length = 0.4 mi. Elev. = 50

85% length = 3.4 mi Elev. = 88

$$S = \frac{88 - 50}{3.4 - .4} = 12.7 \text{ ft./mi.}$$

Surface Storage Index (S_t):

(Information taken from USGS quadrangle)

D.A. = 5440 acres

Storage area = 303 acres

$$S_t = \frac{303}{5440} \times 100 = 6\ \%$$

Manmade Impervious Cover Index (I)

(Population taken from Boro of Medford Lakes and USGS quadrangle.)

Population = 7050 persons

Population Density (D) = $\frac{7050}{8.5}$ = 829 persons/sq. mi.

$I = 0.117\, D^{(0.792 - 0.039 \log D)}$ From Special Report 38

$I = 11.1\ \%$

STORCH ENGINEERS

Sheet 7 of 20

Project Birchwood Lake Dam

1132

Made By KL Date 3-7-79

Chkd By DMS Date 3-14-79

Lake Storage Volume

From USGS & Aerial photos

Stage (ft.)	Surface area (Ac)
36.0	0
43.0	11.0
50.0	58.0

HEC-1-DB Program will develope storage capacity from surface & elev.

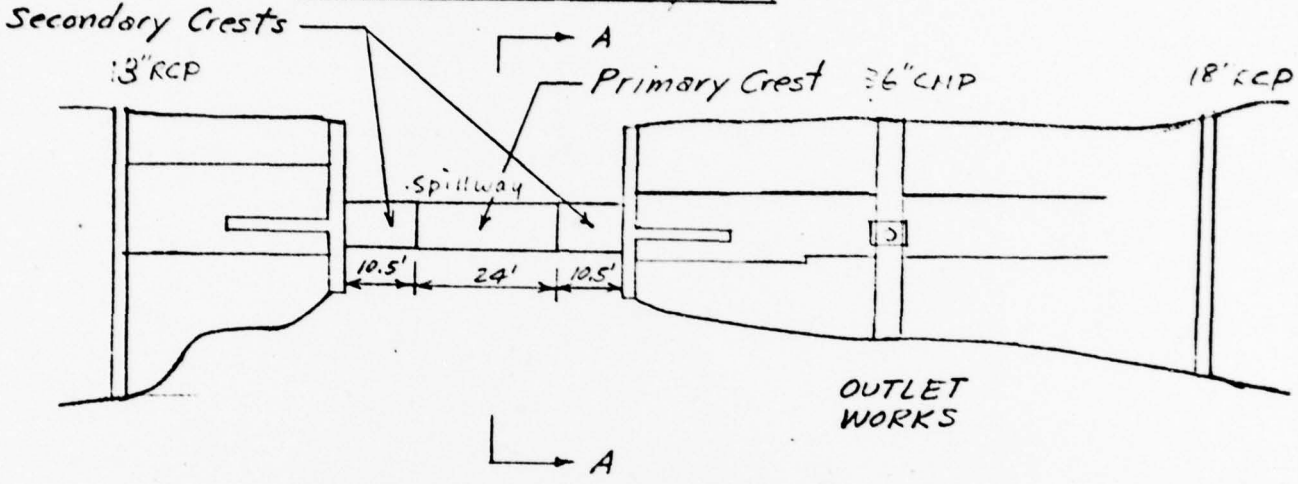
STORCH ENGINEERS

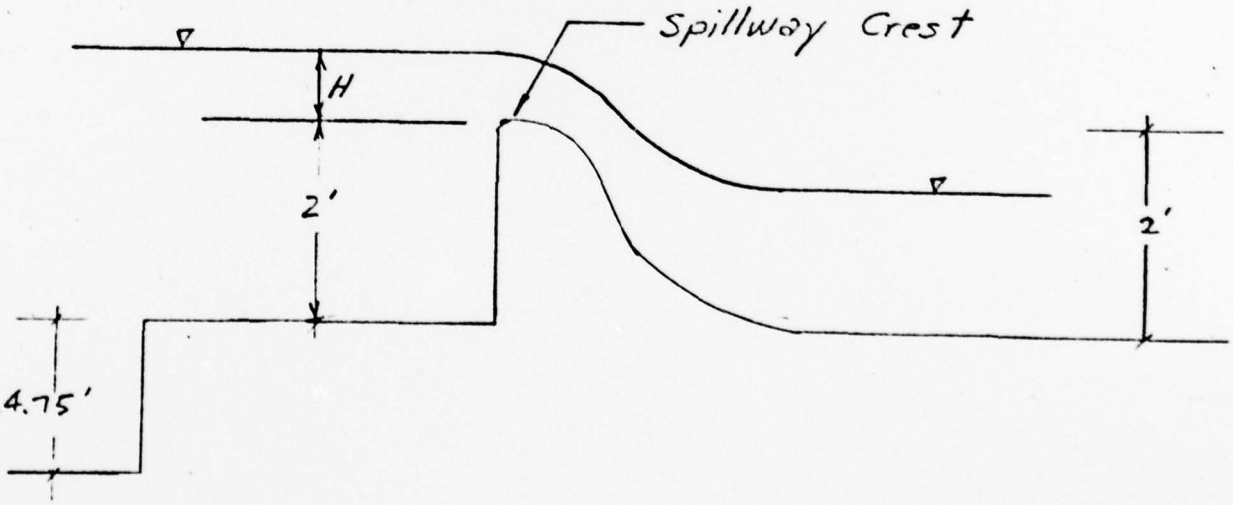
Sheet 8 of 20

Project Birchwood Lake Dam Made By RL Date 5-12-79

Chkd By DMF Date 5-14-79

Spillway Discharge





SECTION A-A

SPILLWAY DISCHARGE

Sources: Ogee crest spillway - Design of Small Dams
Auxilliary spillways - Hydraulic Charts for the Selection of Highway Culverts.

Ogee Crest Spillway -

$$Q = CLH^{3/2}$$

$L_1 = 24'$ effective length of primary crest
$L_2 = 21'$ effective length of secondary crest
C_1, C_2 coef. of discharge for L_1, L_2 respectively.

STAGE - DISCHARGE TABULATION

Stage Elev.	Spillway C_1, C_2	Spillway Q (cfs)	Auxiliary Spillway Q (cfs) (Outlet Control)	Total Q (cfs)
42.8	3.6	0	0	0
43.0	3.6	8	0	8
43.5	3.6	77	4	81
44.0	3.6	189	8	197
44.5	3.6	330	14	344
46.5	3.5	1078	30	1108
48.5	2.3	1349	30	1379

STORCH ENGINEERS

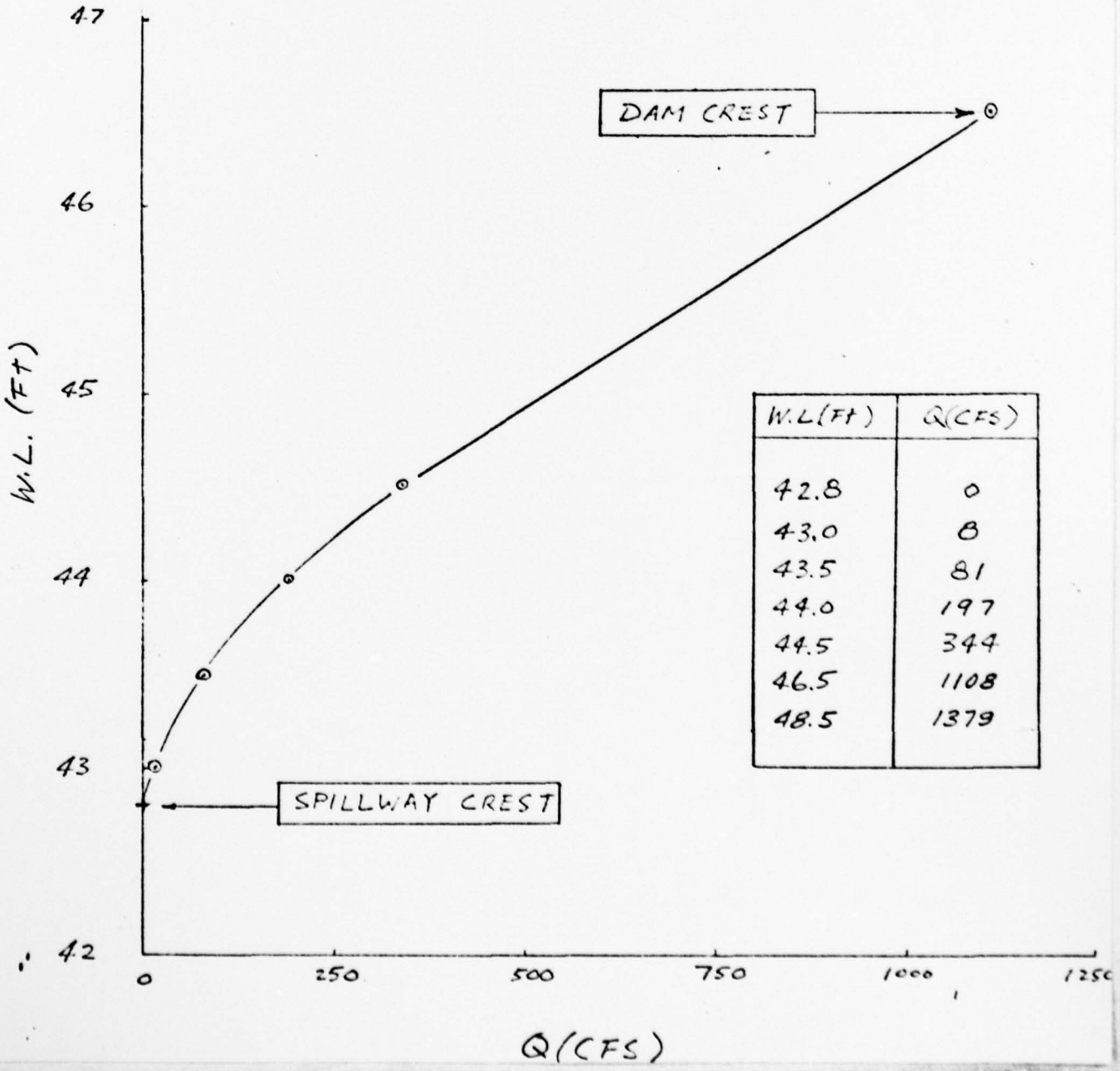
Sheet 10 of 20

Project 1132 Birchwood Lake Dam

Made By RL Date 3-8-79

Chkd By DMP Date 3-14-79

STAGE DISCHARGE CURVE



W.L(Ft)	Q(CFS)
42.8	0
43.0	8
43.5	81
44.0	197
44.5	344
46.5	1108
48.5	1379

Lake Storage Volume

From USGS & Aerial Photos

Stage (ft)	Surface area (Ac)
29.8	0
41.0	16.5
50.0	92.0

HEC-1-DB will develope storage capacity from surface area & elevation.

STORCH ENGINEERS

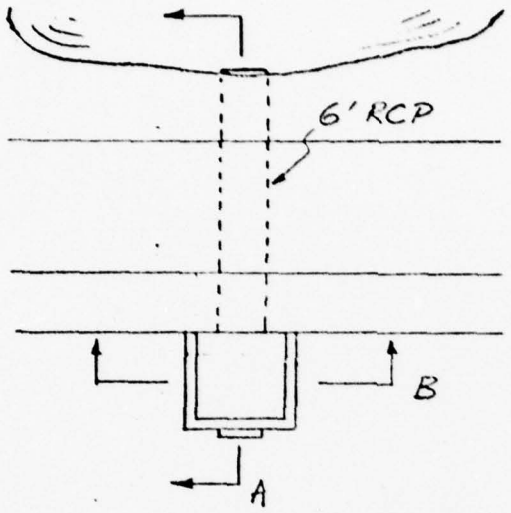
Sheet 12 of 20

Project Timber Lake Dam

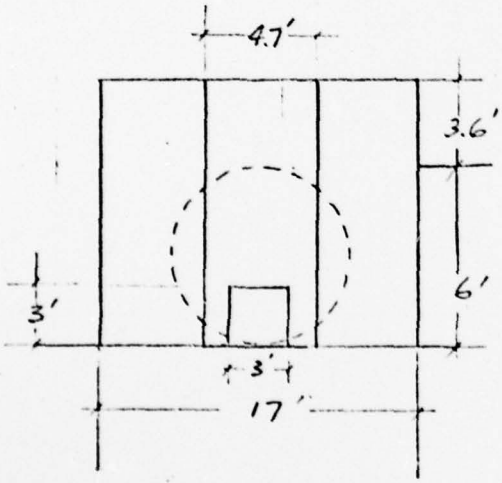
Made By EL Date 3-12-79

1132

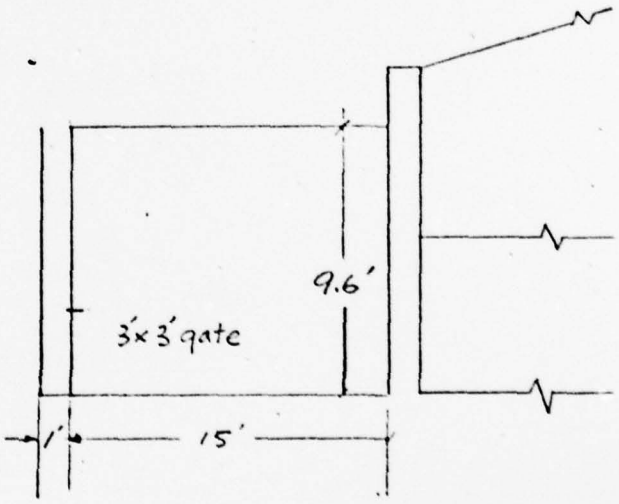
Chkd By [illegible] Date 3-14-79



Top of dam 44.1
Length of dam 300'



Section B



Section A

All inside dimensions

Stage Discharge Tabulation

Effective length of stage 1 weir $L_1 = 4.5'$
" " " " 2 " $L_2 = 38.0'$
(Effective length = inside length - losses at corners)

Coef of discharge $C_1 = 3.3$
Coef of discharge $C_2 = 2.7$ to 3.3,
Q_{pipe} discharge thru 6' pipe with TW = 7' to 8.5'
(Outlet control)

W.L. (ft)	h_1 (ft)	Q_1 (cfs)	h_2 (ft)	C_2	Q_2	Q_1+Q_2 (cfs)	Q_{pipe} (cfs)	Q_c (cfs)
40.6	0	0	0	-	0	0	0	0
41.1	0.5	5	0.5	2.7	36	41	41	41
41.6	1.0	15	1.0	3.0	114	129	129	129
42.1	1.5	27	1.5	3.2	223	250	250	250
42.6	2.0	42	2.0	3.3	354	396	396	396
43.1	2.5	59	2.5	3.3	495	554	505	505
43.6	3.0	77	3.0	3.3	652	729	515	515
44.1	3.5	97	3.5	3.3	821	918	535	535
46.1	5.5	191	5.5	3.3	1618	1809	600	600

PROJECT: Timber Lake Dam 1132 DESIGNER: RL

DATE: 4-4-79

HYDROLOGIC AND CHANNEL INFORMATION

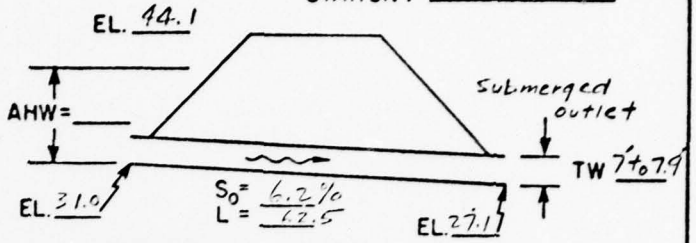
Q_1 = _____ TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: Spillway



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

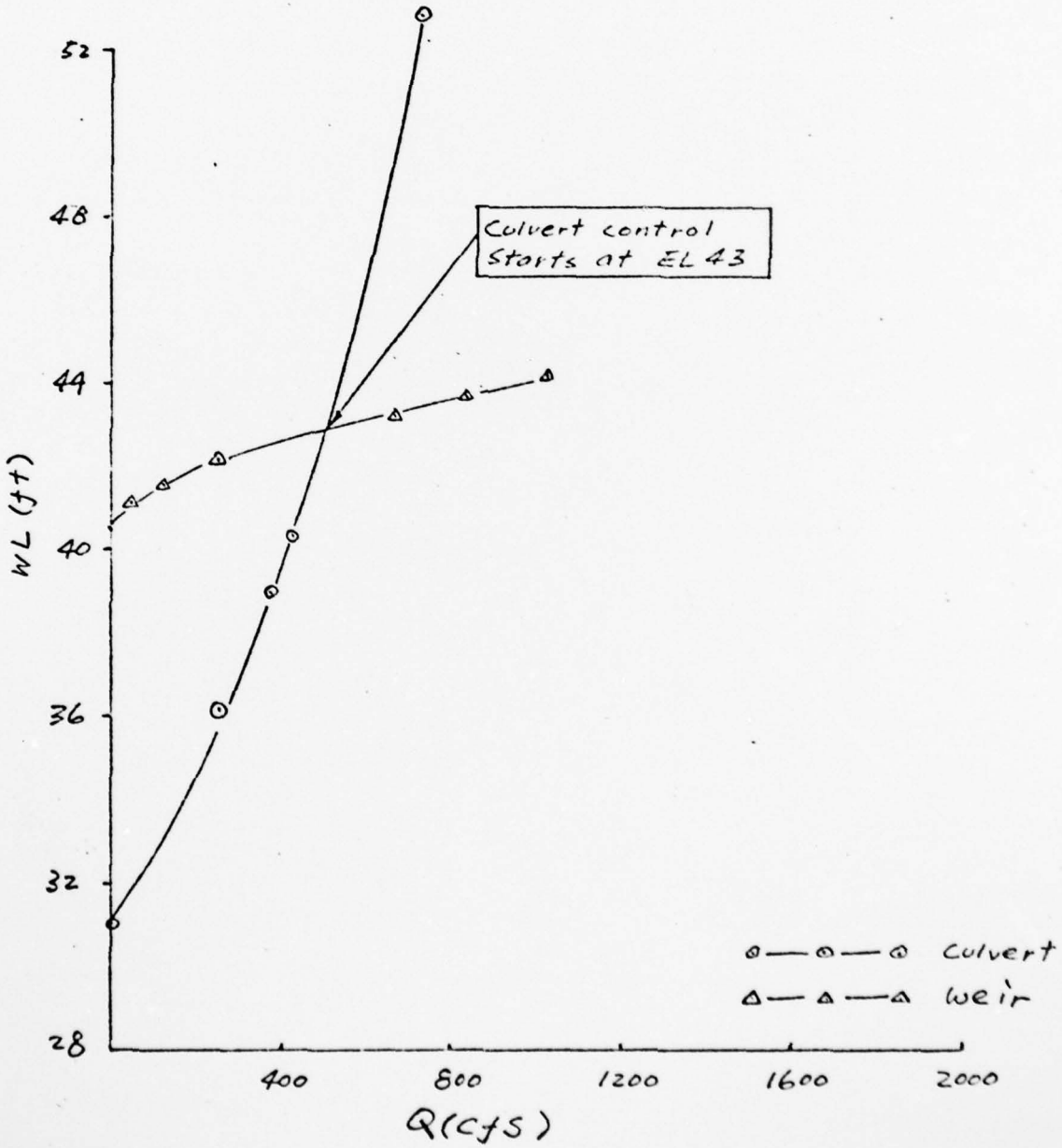
CULVERT DESCRIPTION (ENTRANCE TYPE)	Q cfs	SIZE 72" RCP	HEADWATER COMPUTATION: INLET CONT. $\frac{HW}{D}$	INLET CONT. HW	OUTLET CONTROL $HW=H+h_o-LS_o$: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING HW	OUTLET VELOCITY	COST W.L.	COMMENTS
Headwall	250	"			0.5	2	4.3	5.15	7	7	3.9	5.1	5.1		36.1	
Headwall	375	"			0.5	4.2	5.2	5.6	7.7	7.7	3.7	8.0	8.0		39.0	
Headwall	395	"			0.5	4.7	5.3	5.65	7.8	7.8	3.9	8.6	8.6		39.6	
Headwall	410	"			0.5	5.3	5.4	5.7	7.9	7.9	3.9	9.3	9.3		40.3	
Headwall	729	"			0.5	17	6	6	7.3	8.8	3.9	21.9	21.9		52.9	

SUMMARY & RECOMMENDATIONS:

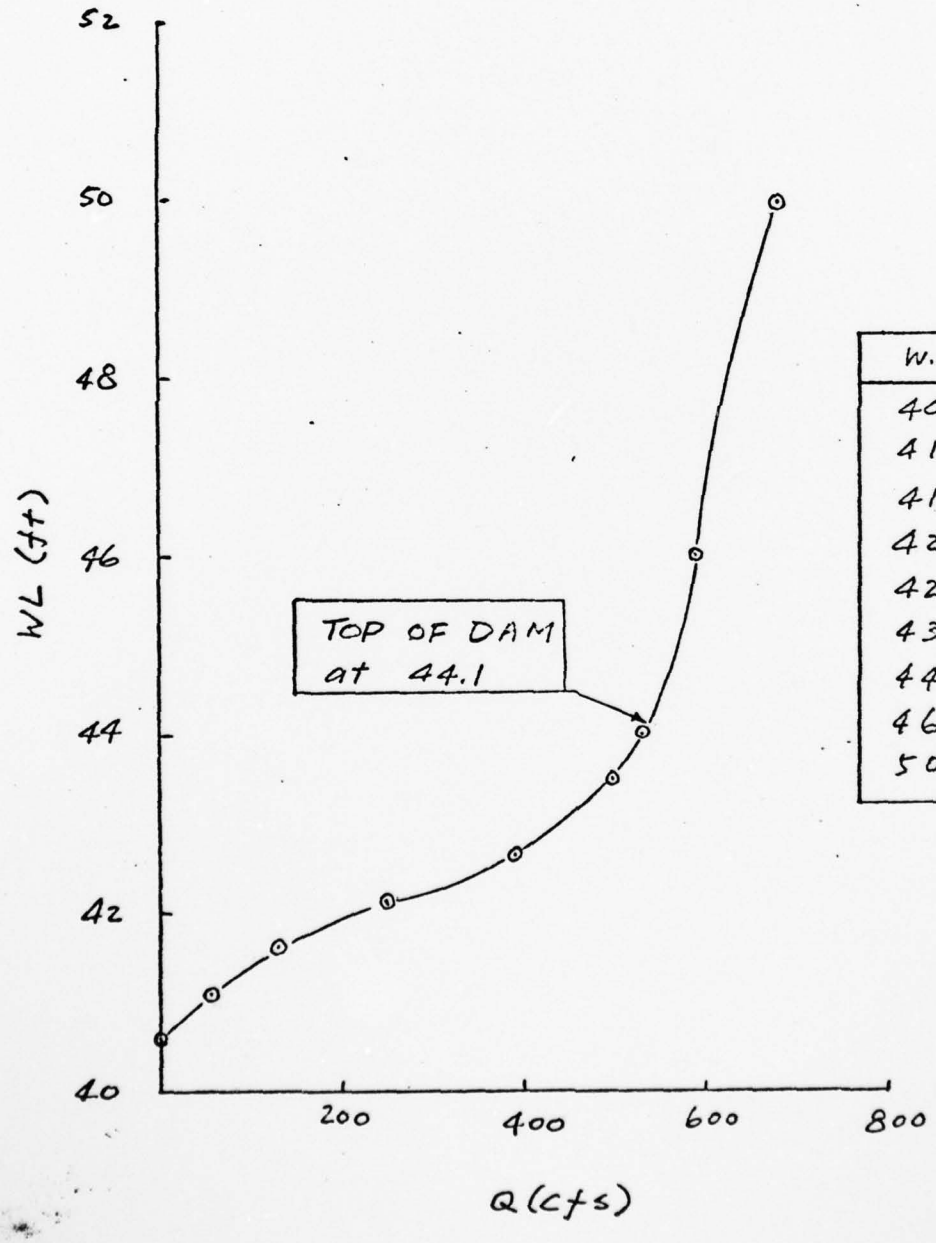
S-13

Figure 7

Stage Discharge Curve for Weir and Culvert

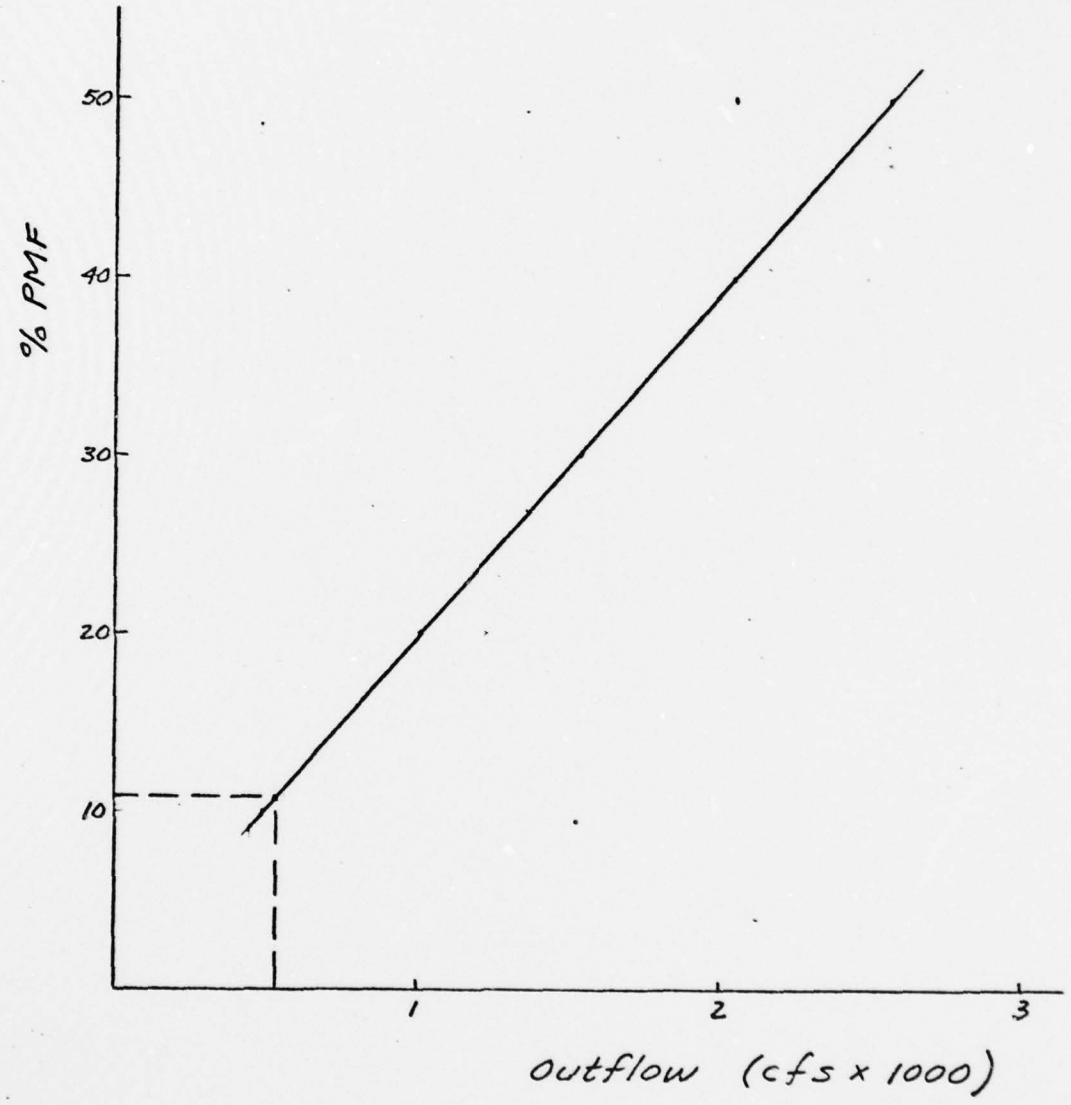


Stage Discharge Curve for Timber Lake Dam Spillway



W.L.(ft)	Q(cfs)
40.6	0
41.1	41
41.6	129
42.1	250
42.6	396
43.0	500
44.0	530
46.0	590
50.0	680

OVERTOPPING POTENTIAL



Overtopping occurs at elev. 44.1 with Q = 535 cfs

∴ Dam can pass approximately 11 % PMF

AD-A068 673 NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. TIMBER LAKE DAM (NJ 00416), DELAWA--ETC(U)
MAY 79 R J MCDERMOTT DACW61-78-C-0124

UNCLASSIFIED NL

2 OF 2
AD
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END
DATE
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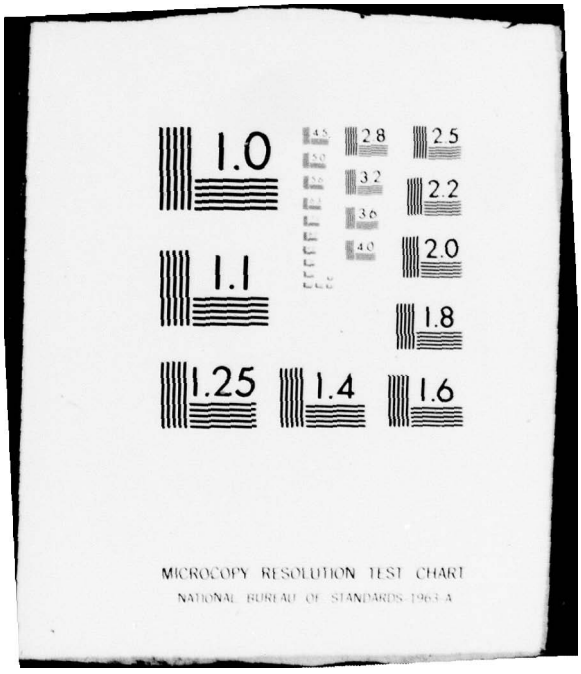
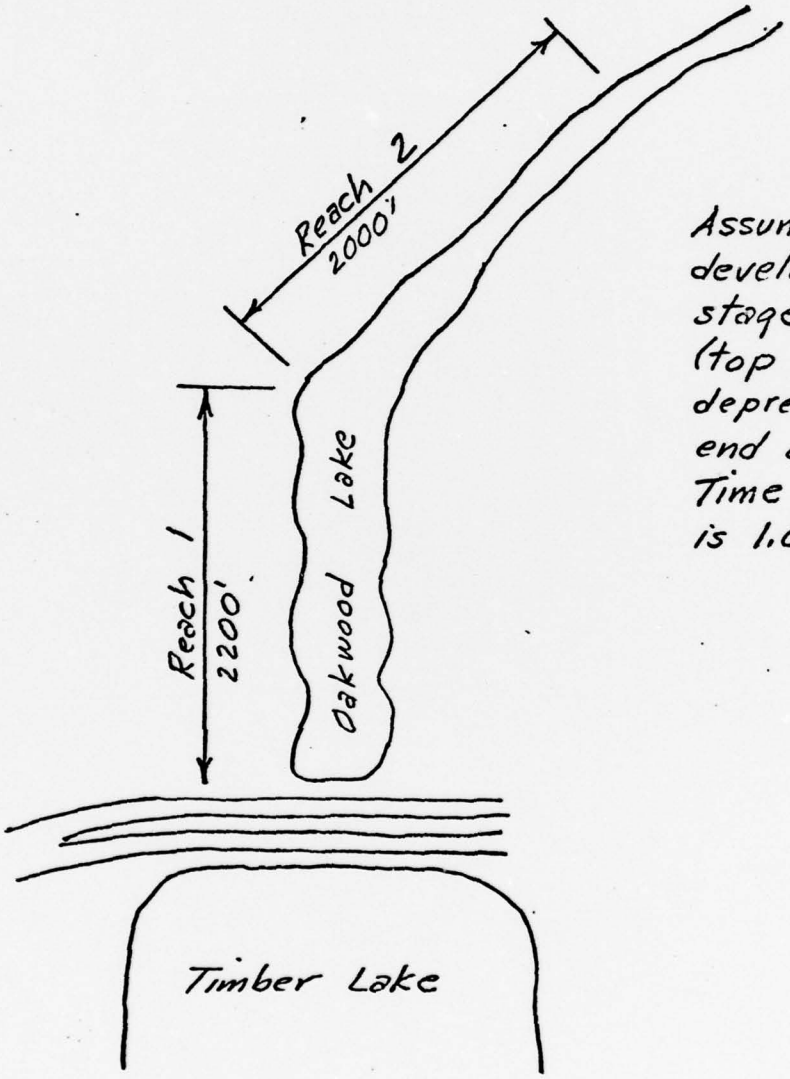
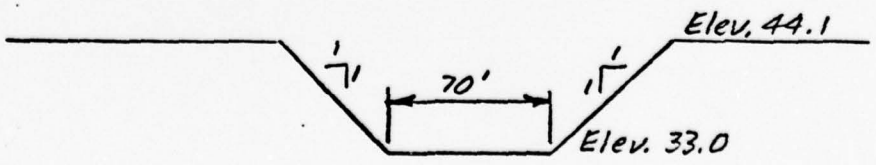

1.0
1.1
1.25
1.4
1.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

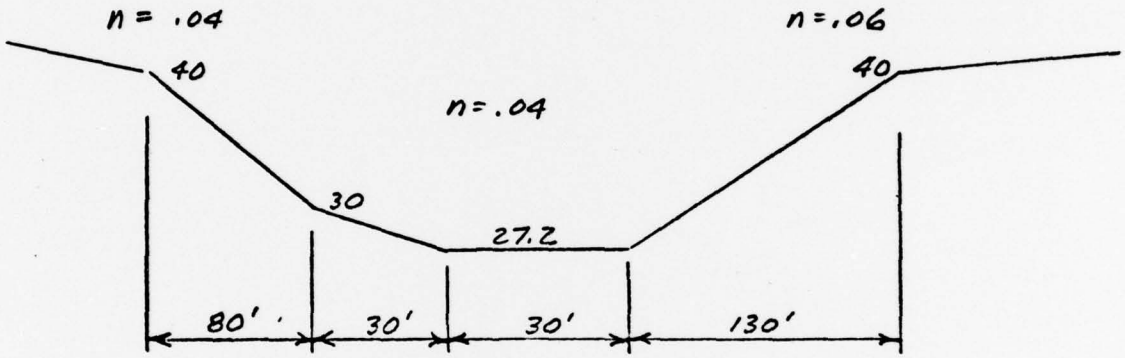
BREACH ANALYSIS



Assume breach begins to develop when reservoir stage reaches elev. 44.1 (top of dam, 0.5' above depressed areas at each end of dam crest) Time to fully develop is 1.0 hour.



FULLY DEVELOPED BREACH



CROSS SECTION
END OF REACH 2

S = 0.0014

Elev. of lowest home = 33 ±

STORCH ENGINEERS

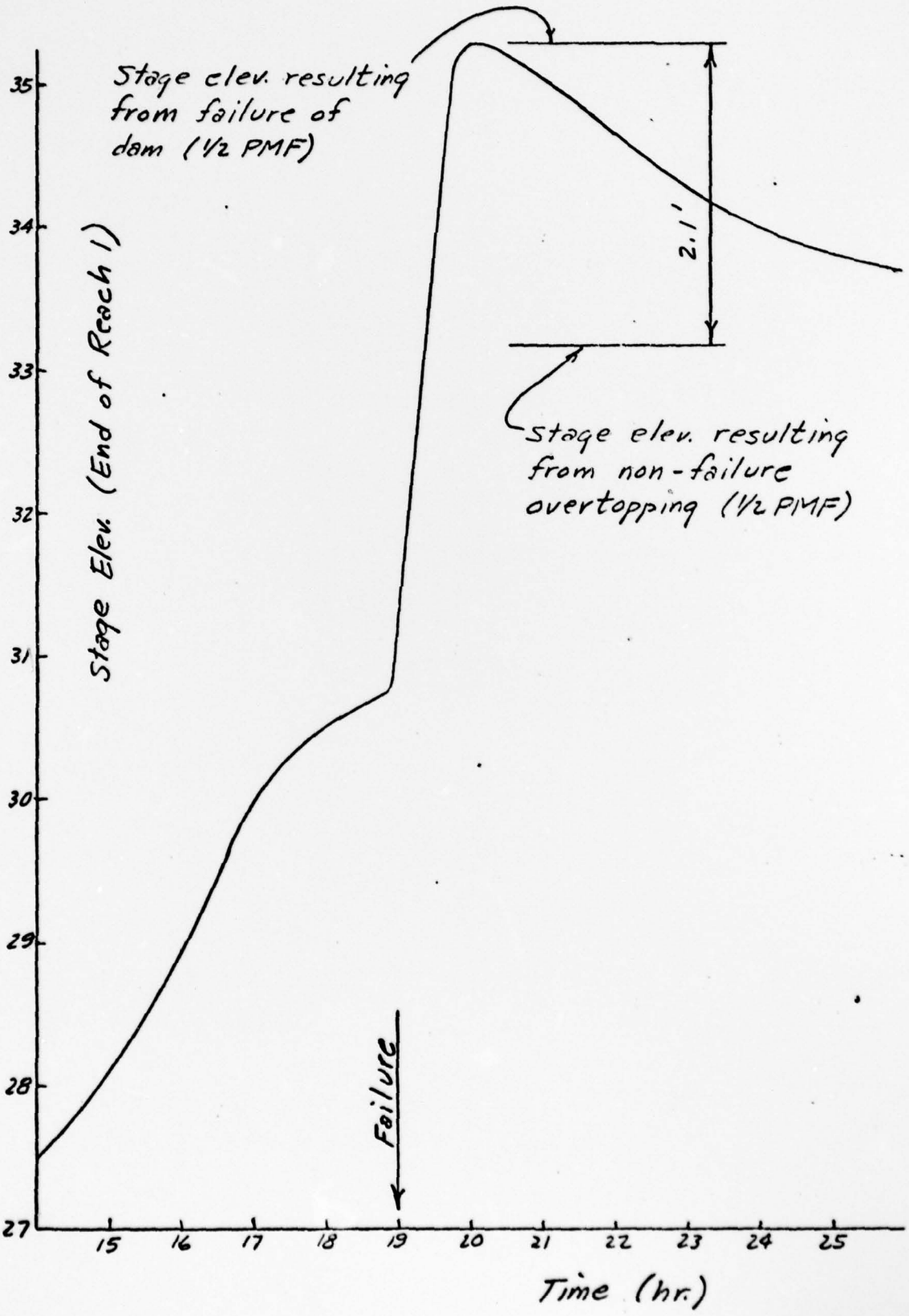
Sheet 20 of 20

Project 1132

Made By JG Date 4-6-79

Timber Lake Dam

Chkd By _____ Date _____



HEC-1-DB COMPUTATIONS

```
A1                                   NATIONAL DAM SAFETY PROGRAM
A2                          TIMBER LAKE DAM                    NEW JERSEY
A3                          MULTI RATIO ROUTING
B     250         1         0                                        0         0         3
B1      5
J       1         5         1
J1    0.1       0.2       0.3       0.4       0.5
K       0  TIMPER                                0         0         1
K1                  SUBAREA INFLOW HYDROGRAPH FOR BIRCHWOOD LAKE
M       1         0       8.5                 8.5         0
P       0        27       100       109       117
T                                                                 1.5      0.15
V     5.5      17.6         0
X    -1.0     -0.05       2.0
K       1  TIMLK                                 0         0         1
K1                  ROUTE DISCHARGE THRU BIRCHWOOD LK DAM
Y                                         1         1
Y1      1                                                        -42.8        -1
Y4   42.8      43.0      43.5      44.0      44.5      45.0      45.5      46.0      46.5      48.5
Y5      0         8        81       197       344       543       742       941      1108      1379
$A      0      11.0      58.0
$E   36.0      43.0      50.0
$$   42.8
$D   46.5      2.63       1.5       175
K       1  TIMLK                                 0         0         1
K1                  ROUTE HYDROGRAPH THRU TIMBER LK DAM
Y                                         1         1
Y1      1                                                        -40.6        -1
Y4   40.6      41.1      41.6      42.1      42.6      43.1      43.6      44.1      46.1
Y5      0        41       129       250       396       505       515       535       600
$A      0      16.5      92.0
$E   29.6      41.0      50.0
$$   40.6
$D   44.1      2.63       1.5       300
K      99
A
A
A
A
A
```

FORM 14852
J.C. Computer Forms Div.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  11 JAN 79
**********

RUN  DATE= 79/04/05.
     TIME= 11.57.52.
```

NATIONAL DAM SAFETY PROGRAM
TIMBER LAKE DAM NEW JERSEY
MULTI RATIO ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
250	1	0	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1

RTIOS= .10 .20 .30 .40 .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUBAREA INFLOW HYDROGRAPH FOR BIRCHWOOD LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
TIMBER	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	0	8.50	0.00	8.50	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	27.00	100.00	109.00	117.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.50	.15	0.00	0.00

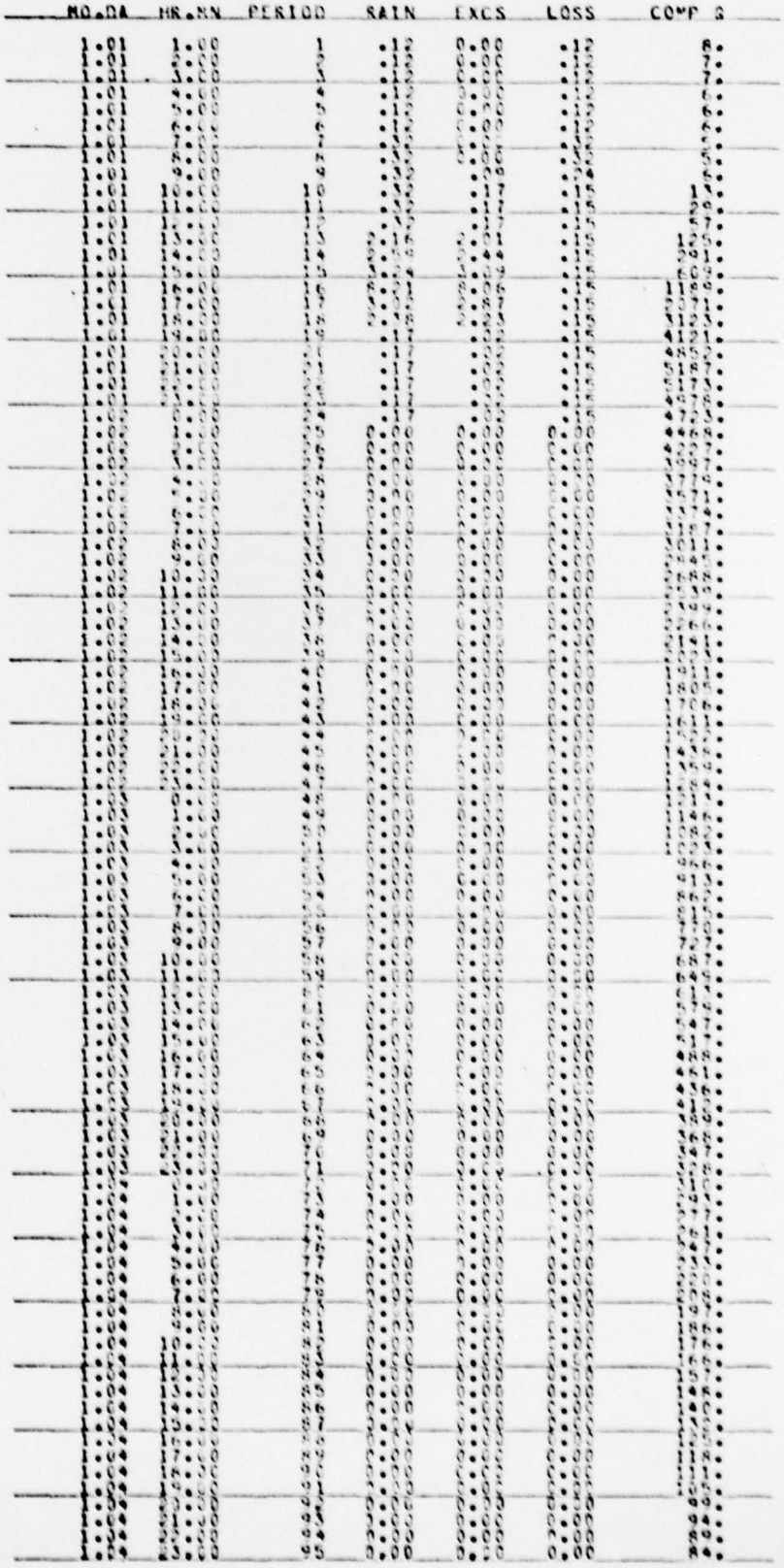
UNIT HYDROGRAPH DATA
TC= 5.50 R= 17.60 NTA= 0

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 97 END-OF-PERIOD ORDINATES, LAG= 5.76 HOURS, CP= .27 VOL= 1.00

17.	63.	128.	195.	244.	261.	253.	239.	226.	213.
201.	190.	180.	170.	160.	152.	143.	135.	128.	121.
114.	108.	102.	96.	91.	86.	81.	77.	72.	68.
65.	61.	58.	54.	51.	49.	46.	43.	41.	39.
37.	35.	33.	31.	29.	28.	26.	25.	23.	22.
21.	20.	19.	17.	17.	16.	15.	14.	13.	12.
12.	11.	10.	10.	9.	9.	8.	8.	7.	7.
7.	6.	6.	6.	5.	5.	5.	4.	4.	4.
4.	4.	3.	3.	3.	3.	3.	3.	2.	2.
2.	2.	2.	2.	2.	2.	2.			

PMF HYDROGRAPH
INFLOW INTO BIRCHWOOD LAKE



1/2 PMF HYDROGRAPH
INFLOW INTO TIMBER LAKE FROM BIRCHWOOD LAKE DAM

```
                                   STATION  TIMLK, PLAN 1, RATIO 5
                                 END-OF-PERIOD HYDROGRAPH ORDINATES
                                            OUTFLOW
       1.        2.        2.        2.        3.        3.        3.        3.        3.        3.
       5.       12.       35.       80.      197.      418.      763.     1139.     1728.     2235.
    2511.     2591.     2538.     2424.     2297.     2174.     2057.     1945.     1840.     1739.
    1644.     1555.     1471.     1391.     1317.     1248.     1183.     1127.     1076.     1016.
     958.      898.      844.      796.      751.      708.      668.      631.      595.      562.
     532.      501.      473.      445.      421.      398.      376.      355.      336.      319.
     302.      285.      269.      254.      240.      227.      214.      202.      192.      182.
     172.      162.      153.      145.      137.      129.      122.      115.      109.      103.
      97.       92.       86.       82.       78.       74.       70.       66.       63.       60.
      56.       53.       50.       47.       45.       42.       40.       38.       36.       34.
      32.       30.       28.       27.       25.       24.       22.       21.       20.       19.
      17.       16.       15.       14.       13.       12.       11.       11.       10.        9.
       9.        8.        8.        8.        7.        7.        7.        6.        6.        5.
       5.        5.        5.        4.        4.        4.        4.        3.        3.        3.
       3.        3.        2.        2.        2.        2.        2.        2.        2.        1.
       1.        1.        1.        1.        1.        1.        1.        1.        1.        1.
       1.        1.        1.        1.        1.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
       0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                                            STORAGE
      24.       24.       24.       24.       24.       24.       24.       24.       24.       24.
      25.       26.       28.       32.       39.       51.       69.       98.      129.      151.
     162.      165.      163.      158.      153.      148.      143.      138.      134.      129.
     125.      121.      117.      113.      109.      105.      101.       97.       92.       87.
      82.       78.       74.       71.       68.       66.       64.       62.       60.       58.
      56.       55.       53.       52.       51.       50.       49.       48.       47.       46.
      45.       44.       43.       42.       41.       40.       40.       39.       38.       38.
      37.       37.       36.       35.       35.       35.       34.       34.       33.       33.
      33.       32.       32.       32.       31.       31.       31.       30.       30.       30.
      30.       29.       29.       29.       29.       28.       28.       28.       28.       28.
      28.       27.       27.       27.       27.       27.       27.       27.       27.       26.
      26.       26.       26.       26.       26.       26.       26.       26.       26.       26.
      26.       26.       26.       26.       25.       25.       25.       25.       25.       25.
      25.       25.       25.       25.       25.       25.       24.       24.       24.       24.
      24.       24.       24.       24.       24.       24.       24.       24.       24.       24.
      24.       24.       24.       24.       24.       24.       24.       24.       24.       24.
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      24.       24.       24.       24.       24.       24.       24.       24.       24.       24.
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                                              STAGE
  42.8      42.9      42.9      42.9      42.9      42.9      42.9      42.9      42.9      42.9
  42.9      43.0      43.2      43.5      44.0      44.7      45.6      46.6      47.5      48.1
  48.3      48.4      48.4      48.3      48.1      48.0      47.9      47.8      47.7      47.5
  47.4      47.3      47.2      47.1      47.0      46.8      46.7      46.6      46.4      46.2
  46.1      45.9      45.8      45.6      45.5      45.4      45.3      45.2      45.1      45.0
  45.0      44.9      44.8      44.8      44.7      44.6      44.6      44.5      44.5      44.4
  44.4      44.3      44.2      44.2      44.1      44.1      44.1      44.0      44.0      43.9
  43.9      43.9      43.8      43.8      43.7      43.7      43.7      43.6      43.6      43.6
  43.6      43.5      43.5      43.5      43.5      43.5      43.4      43.4      43.4      43.4
  43.3      43.3      43.3      43.3      43.3      43.2      43.2      43.2      43.2      43.2
  43.2      43.2      43.1      43.1      43.1      43.1      43.1      43.1      43.1      43.1
  43.1      43.1      43.0      43.0      43.0      43.0      43.0      43.0      43.0      43.0
  43.0      43.0      43.0      43.0      43.0      43.0      43.0      43.0      42.9      42.9
  42.9      42.9      42.9      42.9      42.9      42.9      42.9      42.9      42.9      42.9
  42.9      42.9      42.9      42.9      42.9      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
  42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8      42.8
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SUMMARY OF DAM SAFETY ANALYSIS
AT BIRCHWOOD LAKE DAM (DAM OVERTOPPED)

.....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	42.80	42.80	46.50
STORAGE	24.	24.	95.
OUTFLOW	0.	0.	1108.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	44.93	0.00	55.	516.	0.00	22.00	0.00
.20	46.22	0.00	85.	1014.	0.00	23.00	0.00
.30	47.30	.80	121.	1548.	10.00	22.00	0.00
.40	47.91	1.41	144.	2071.	16.00	22.00	0.00
.50	48.42	1.92	165.	2591.	21.00	22.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS
AT TIMBER LAKE DAM (DAM OVERTOPPED)

.....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	40.60	40.60	44.10
STORAGE	55.	55.	140.
OUTFLOW	0.	0.	535.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	43.04	0.00	107.	492.	0.00	24.00	0.00
.20	44.79	.69	167.	1014.	16.00	23.00	0.00
.30	45.24	1.14	186.	1538.	24.00	23.00	0.00
.40	45.61	1.51	203.	2052.	30.00	22.00	0.00
.50	45.94	1.84	219.	2570.	34.00	22.00	0.00

```
A1                    NATIONAL DAM SAFETY PROGRAM
A2                TIMBER LAKE DAM                    NEW JERSEY
A3                          0.5 PMF BREACH CHANNEL ROUTING
B     250          1          0                                   0         0         3
B1      5
J       1          1          1
J1    0.5
K       0    BIRCH                                  0         0         1
K1                SUBAREA INFLOW HYDROGRAPH FOR BIRCHWOOD LAKE
M       1          0        8.5                    8.5         0
P       0         27        100       109          117
T                                                                    1.5      0.15
V     5.5       17.6          0
X    -1.0      -0.05        2.0
K       1    TIMLK                                  0         0         1
K1                ROUTE DISCHARGE THRU BIRCHWOOD LK DAM
Y                                                    1         1
Y1      1                                                      -42.8        -1
Y4   42.8       43.0       43.5       44.0       44.5       45.0       45.5      46.0      46.5      48.5
Y5      0          8         81        197        344        543        742       941      1108      1379
$A      0       11.0       58.0
$E   36.0       43.0       50.0
$$   42.8
$O   46.5       2.63        1.5        175
K       1    TIMLK                                  0         0         1
K1              ROUTE HYDROGRAPH THRU TIMBER LK DAM
Y                                                    1         1
Y1      1                                                      -40.6        -1
Y4   40.6       41.1       41.6       42.1       42.6       43.1       43.6      44.1      46.1
Y5      0         41        129        250        396        505        515       535       600
$A      0       15.5       92.0
$E   29.8       41.0       50.0
$$   40.6
$O   44.1       2.63        1.5        300
$B   70.0        1.0       33.0          1       40.6       44.1
K       1          1                                                      1
K1                          CHANNEL ROUTING - REACH 1
Y                                                    1         1
Y1      1
Y6    .03        .04        .06         30         45       2200     .0014
Y7      0         45         20         44        120         42       130        33       230        33
Y7    240         42        500         45       1040         50
K       1          2                                                      1
K1                          CHANNEL ROUTING - REACH 2
Y                                                    1         1
Y1      1
Y6    .04        .04        .06       27.2         45       2000     .0014
Y7      0         50        700         40        780         30       810      27.2       840      27.2
Y7    970         40       1470         45       1970         50
K      99
```

HYDROGRAPH ROUTING

CHANNEL ROUTING - REACH 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0400	.0400	.0600	27.2	45.0	2000.	.00140

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 50.00 700.00 40.00 780.00 30.00 810.00 27.20 840.00 27.20
970.00 40.00 1470.00 45.00 1970.00 50.00

STORAGE	0.00	1.71	4.25	7.66	11.83	16.74	22.39	28.76	35.86	43.70
	52.27	61.57	71.60	82.36	94.20	111.55	135.75	166.80	204.70	249.45
OUTFLOW	0.00	42.90	157.29	353.69	669.98	1090.07	1623.45	2279.38	3066.94	3995.02
	5072.35	6307.44	7708.63	9284.08	10929.59	12928.90	15539.12	18771.86	22694.75	27385.25
STAGE	27.20	28.14	29.07	30.01	30.95	31.89	32.82	33.76	34.69	35.63
	36.57	37.51	38.44	39.38	40.32	41.25	42.19	43.13	44.06	45.00
FLOW	0.00	42.90	157.29	353.69	669.98	1090.07	1623.45	2279.38	3066.94	3995.02
	5072.35	6307.44	7708.63	9284.08	10929.59	12928.90	15539.12	18771.86	22694.75	27385.25

1/2 PMF BREACH HYDROGRAPH
REACH 2

MO.DA	HR.MN	PERIOD	EOP STOR	AVG IN	EOP OUT	STAGE	AVG PUMP
1.01	1.00	1	0.	0.	0.	27.2	0.
1.01	2.00	2	0.	0.	0.	27.2	0.
1.01	3.00	3	0.	1.	1.	27.2	0.
1.01	4.00	4	0.	1.	1.	27.2	0.
1.01	5.00	5	0.	1.	1.	27.2	0.
1.01	6.00	6	0.	2.	2.	27.2	0.
1.01	7.00	7	0.	2.	2.	27.2	0.
1.01	8.00	8	0.	2.	2.	27.2	0.
1.01	9.00	9	0.	2.	2.	27.2	0.
1.01	10.00	10	0.	2.	2.	27.3	0.
1.01	11.00	11	0.	3.	3.	27.3	0.
1.01	12.00	12	0.	3.	3.	27.3	0.
1.01	13.00	13	0.	5.	5.	27.3	0.
1.01	14.00	14	1.	13.	13.	27.5	0.
1.01	15.00	15	2.	40.	40.	28.1	0.
1.01	16.00	16	4.	115.	136.	28.9	0.
1.01	17.00	17	8.	286.	346.	30.2	0.
1.01	18.00	18	10.	469.	532.	30.5	0.
1.01	19.00	19	17.	891.	1088.	31.9	0.
1.01	20.00	20	41.	2672.	3669.	35.3	0.
1.01	21.00	21	39.	3547.	3466.	35.1	0.
1.01	22.00	22	27.	2607.	2054.	33.4	0.
1.01	23.00	23	34.	2515.	2808.	34.4	0.
1.02	0.00	24	30.	2545.	2376.	33.9	0.
1.02	1.00	25	29.	2361.	2352.	33.8	0.
1.02	2.00	26	28.	2283.	2239.	33.7	0.
1.02	3.00	27	27.	2129.	2060.	33.4	0.
1.02	4.00	28	26.	2035.	2019.	33.4	0.
1.02	5.00	29	25.	1910.	1843.	33.1	0.
1.02	6.00	30	24.	1817.	1800.	33.1	0.
1.02	7.00	31	23.	1710.	1655.	32.9	0.
1.02	8.00	32	22.	1621.	1601.	32.8	0.
1.02	9.00	33	21.	1530.	1488.	32.6	0.
1.02	10.00	34	20.	1450.	1427.	32.5	0.
1.02	11.00	35	19.	1371.	1338.	32.3	0.
1.02	12.00	36	19.	1298.	1275.	32.2	0.
1.02	13.00	37	18.	1230.	1203.	32.1	0.
1.02	14.00	38	17.	1168.	1148.	32.0	0.
1.02	15.00	39	17.	1113.	1092.	31.9	0.
1.02	16.00	40	16.	1059.	1040.	31.8	0.
1.02	17.00	41	15.	1001.	979.	31.6	0.
1.02	18.00	42	15.	942.	921.	31.5	0.
1.02	19.00	43	14.	884.	864.	31.4	0.
1.02	20.00	44	14.	831.	813.	31.3	0.
1.02	21.00	45	13.	784.	767.	31.2	0.
1.02	22.00	46	12.	739.	724.	31.1	0.
1.02	23.00	47	12.	698.	683.	31.0	0.
1.03	0.00	48	12.	658.	646.	30.9	0.
1.03	1.00	49	11.	622.	610.	30.8	0.
1.03	2.00	50	11.	587.	576.	30.7	0.
1.03	3.00	51	10.	554.	543.	30.6	0.
1.03	4.00	52	10.	523.	513.	30.5	0.
1.03	5.00	53	9.	494.	484.	30.4	0.
1.03	6.00	54	9.	466.	457.	30.3	0.
1.03	7.00	55	9.	440.	432.	30.2	0.
1.03	8.00	56	8.	416.	408.	30.2	0.
1.03	9.00	57	8.	393.	385.	30.1	0.
1.03	10.00	58	8.	371.	363.	30.0	0.
1.03	11.00	59	8.	351.	345.	30.0	0.
1.03	12.00	60	7.	333.	328.	29.9	0.
1.03	13.00	61	7.	316.	311.	29.8	0.
1.03	14.00	62	7.	299.	294.	29.7	0.
1.03	15.00	63	6.	282.	277.	29.6	0.
1.03	16.00	64	6.	266.	262.	29.6	0.
1.03	17.00	65	6.	251.	247.	29.5	0.
1.03	18.00	66	6.	237.	233.	29.4	0.
1.03	19.00	67	5.	224.	220.	29.4	0.
1.03	20.00	68	5.	212.	208.	29.3	0.
1.03	21.00	69	5.	200.	197.	29.3	0.
1.03	22.00	70	5.	190.	187.	29.2	0.
1.03	23.00	71	5.	180.	177.	29.2	0.
1.04	0.00	72	4.	170.	167.	29.1	0.
1.04	1.00	73	4.	160.	158.	29.1	0.
1.04	2.00	74	4.	152.	150.	29.0	0.
1.04	3.00	75	4.	143.	141.	29.0	0.
1.04	4.00	76	4.	135.	134.	28.9	0.
1.04	5.00	77	4.	128.	127.	28.8	0.
1.04	6.00	78	3.	122.	120.	28.8	0.
1.04	7.00	79	3.	115.	114.	28.7	0.
1.04	8.00	80	3.	109.	107.	28.7	0.
1.04	9.00	81	3.	103.	102.	28.6	0.
1.04	10.00	82	3.	97.	96.	28.6	0.
1.04	11.00	83	3.	92.	91.	28.5	0.
1.04	12.00	84	3.	87.	85.	28.5	0.
1.04	13.00	85	3.	82.	81.	28.5	0.
1.04	14.00	86	2.	78.	77.	28.4	0.
1.04	15.00	87	2.	75.	74.	28.4	0.
1.04	16.00	88	2.	71.	70.	28.4	0.
1.04	17.00	89	2.	67.	66.	28.3	0.
1.04	18.00	90	2.	63.	62.	28.3	0.
1.04	19.00	91	2.	60.	59.	28.3	0.
1.04	20.00	92	2.	57.	56.	28.2	0.
1.04	21.00	93	2.	53.	53.	28.2	0.
1.04	22.00	94	2.	50.	50.	28.2	0.
1.04	23.00	95	2.	48.	47.	28.2	0.

SUMMARY OF DAM SAFETY ANALYSIS

.....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	40.60	40.60	44.10
	STORAGE	55.	55.	140.
	OUTFLOW	0.	0.	535.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	45.03	.93	177.	4740.	1.52	19.78	19.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	4097.	40.6	20.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	3669.	35.3	20.00

APPENDIX 5

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